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Report to the Ranking Member, Committee on Transportation and Infrastructure, House of Representatives

November 2019

AIRPORTS

Information on Prices for Aviation Services and FAA's Oversight of Grant Requirements

GAO-20-16

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GAO Highlights

Highlights of GAO-20-16, a report to the Ranking Member, Committee on Transportation and Infrastructure, House of Representatives

AIRPORTS

Information on Prices for Aviation Services and FAA's Oversight of Grant Requirements

Why GAO Did This Study

Since 2007, the FAA has provided more than $37 billion in grants to airports to fund capital development and is responsible for ensuring compliance with requirements airports assume when they accept these grants. One such requirement is that the airports provide users equal access to airport services such as fueling and parking. Recently, an industry group and pilots raised concerns about the transparency and reasonableness of prices charged for these and other services at airports.

GAO was asked to examine FBOs' pricing and FAA's oversight of related airport grant assurances. This report examines: (1) the transparency of FBO prices, (2) the factors that influence prices, and (3) the extent to which FAA ensures compliance with federal airport grant assurances related to FBO activities.

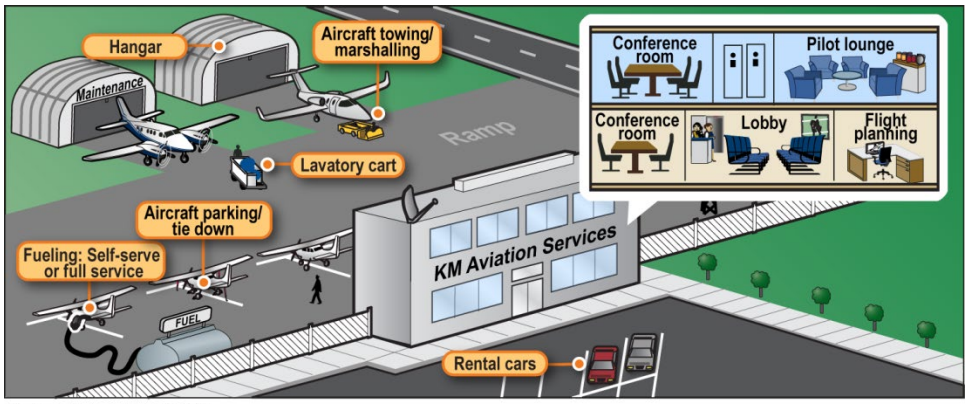
GAO analyzed FAA data related to complaints from 2013 through 2018 and reviewed relevant literature, key laws and regulations, and program documentation. GAO developed a statistical model to analyze variation in fuel prices across airports in the contiguous United States. GAO interviewed FAA compliance staff at headquarters and all regional offices, as well as a non-probability selection of stakeholders.

View GAO-20-16. For more information, contact Andrew Von Ah at (202) 512-2834 or vonaha@gao.gov.

What GAO Found

Fixed base operators (FBO) at airports (see figure) offer a variety of services to pilots and passengers. While anyone can view fuel prices offered by FBOs online, other service fees, such as for aircraft parking, can vary by type of aircraft and are not always available online, although they can be obtained by calling the FBO. Recently, industry groups developed the "Know Before You Go" campaign that calls for greater transparency of FBO prices. Some of the FBOs GAO interviewed list their fees online; however, others do not.

Illustration of Services Provided by Fixed Base Operators at Airports



Source: GAO. | GAO-20-16

Stakeholders GAO interviewed—including general aviation pilots, airports, FBOs, and industry groups—said FBOs' costs to build and maintain facilities—such as hangars and fueling facilities—as well as operating expenses such as labor and fuel—influence their prices. Stakeholders also said that demand for FBOs' services can influence prices, such as when seasonal demand affects operations at an airport near a ski resort. Finally, they also said that competition affects FBO's prices. GAO's statistical model confirmed a correlation between many cost and demand factors and aviation fuel prices and found higher prices at airports with higher costs and demand. This model also found that on-airport competition is associated with lower prices at the country's busiest airports: Prices for aviation fuels were lower at such airports with more than one FBO. However, not all airports can support more than one FBO due to, for example, the amount of business each gets.

Airports receiving Federal Aviation Administration (FAA) grants must meet "grant assurances" such as charging reasonable and not unjustly discriminatory prices for services, including prices charged by FBOs. FAA officials said FAA oversight relies on (1) airports' consent to adhere to grant assurances; (2) training and outreach; and (3) complaints. Since 2013, in complaints received by FAA, GAO found few complaints about FBOs' prices. GAO found each regional office independently records additional inquiries. FAA is moving to collect regional inquires centrally, and by 2020 that step may allow FAA to stay abreast of apparent nationwide trends or issues with any grant assurance concerns.

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Abbreviations

AIP	Airport Improvement Program
AOPA	Aircraft Owners and Pilots Association
DOJ	Department of Justice
FAA	Federal Aviation Administration
FBO	Fixed Base Operator
NPIAS	National Plan of Integrated Airport Systems

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

November 26, 2019

Dear Mr. Graves:

Since 2007, the Federal Aviation Administration (FAA) through the Airport Improvement Program (AIP), has provided more than $37 billion in federal grants to fund airport capital development and is responsible for overseeing airports' compliance with the federal requirements related to these grants, called airport grant assurances. Airports receiving grants agree to meet 39 grant assurances, and one such requirement is that the airport must provide users equal access to airport facilities.[1] Recently some general aviation pilots along with the Aircraft Owners and Pilots Association (AOPA) expressed concerns about the cost and transparency of certain services—primarily aircraft fuel and parking—provided by fixed base operators (FBO) at airports.[2] An FBO usually operates on site as a business providing not only fuel and parking but also, depending on the airport, flight training and, aircraft rental and maintenance, among other things. Approximately 3,000 public use airports in the contiguous United States receive FAA grants and each must ensure that FBOs and other tenants at their airport act in accordance with the conditions of their grant funding.[3]

You asked us to review FBOs' prices and FAA's oversight of airports' grant compliance and FBOs. This report examines:

- the transparency of FBO prices,
- the factors that influence prices, and

[1] FAA Grant Assurance 22b (1) states that an airport must ensure aeronautical services are available to all users on a reasonable, and not unjustly discriminatory basis. 49 U.S.C. § 47107 (a) (1).

[2] "General aviation" includes corporate and recreational flying in addition to important services such as medical transportation, disaster relief, and transportation access to rural and isolated communities, but does not include scheduled airline or military flight activity. According to FAA, in 2017 there were approximately 333,000 active general aviation pilots in the United States who use airports along with 211,000 active general aviation aircraft. The 333,000 figure, the most recent one available, includes pilots with a private, student, sport recreational, and rotocraft certification only and does not include airline transport and glider certified pilots.

[3] Public-use airports range from very large publicly-owned commercial airports to small general aviation airports that may be privately owned but are available for public use.

- the extent to which FAA ensures compliance with federal airport grant assurances related to FBO activities.

To determine what is known about FBOs' price transparency and to help identify the factors that may influence FBOs' prices, we performed a literature search of reports, presentations, and articles about the FBO industry.[4] We also reviewed two websites that list fuel prices for many FBOs as well as individual websites for the 16 FBOs we interviewed, to understand the extent to which prices for FBO services are posted publicly. To add stakeholder perspectives, we selected a non-probability sample of 26 airports and interviewed the airports' officials to discuss their operations and grant oversight process. We selected these airports to obtain a geographic dispersion, aircraft traffic levels, and the number and type of FBOs at the airport, among other factors. We also interviewed 16 FBOs at these airports to discuss their operations, relationship with the airport, and prices.[5] See appendix I for a list of the selected airports and FBOs. We also selected a non-probability sample of 18 general aviation pilots to obtain perspectives on how they view the FBO market and how they choose FBOs to patronize.[6] Our findings from our interviews with airports, FBOs and selected pilots are not generalizable to all airports, FBOs, and pilots.

To further understand factors that correlate with FBO fuel prices, we obtained data on posted aviation fuel prices, information that we used—along with data from FAA, the Department of Commerce's Bureau of Economic Analysis, and other sources, to examine the relationship between the price of aviation fuel and selected cost factors, demand factors, and factors related to the extent of competition among FBOs at each airport. In addition, we met with the Department of Justice (DOJ) to discuss competition and a recent FBO merger. We also discussed our approach for analyzing fuel price information with DOJ officials. See appendix II for further discussion of this analysis. Finally, we also interviewed industry associations—the Aircraft Owners and Pilots

[4] For the purposes of this report, we included only FBOs operating at airports in the contiguous United States that provided fuel services. All references in this report reflect this scope.

[5] We contacted 16 airport sponsors, three of which each spoke for two airports.

[6] To select the pilots, we reached out to GAO employees who knew general aviation pilots and interviewed those who were interested in talking to us. We also asked managers at some airports we visited for names of pilots and interviewed those who were interested in talking to us.

Association, the National Air Transportation Association, the National Business Aircraft Association, Airport Council International–North America, the American Association of Airport Executives, and the General Aviation Manufacturers Association—regarding their perspectives on FBO prices.

To determine the extent to which FAA ensures compliance with federal airport grant assurances related to FBO activities, we reviewed pertinent documentation related to FAA's airport compliance and grant programs, such as its airport compliance manual and complaint procedures. We also reviewed FAA's complaint process including obtaining data on informal and formal complaints made to the agency between 2013 and 2018.[7] We interviewed officials from FAA's Office of Airport Compliance and compliance officials in each of FAA's nine regions to obtain an understanding of their compliance oversight activities. In addition, we asked the selected airport and FBO officials (staff and managers) and industry associations about their observations of FAA oversight.

We conducted this performance audit from April 2018 to October 2019, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[7] Informal complaint procedures are outlined in 14 C.F.R. Part 13 and Formal complaint procedures are in Part 16.

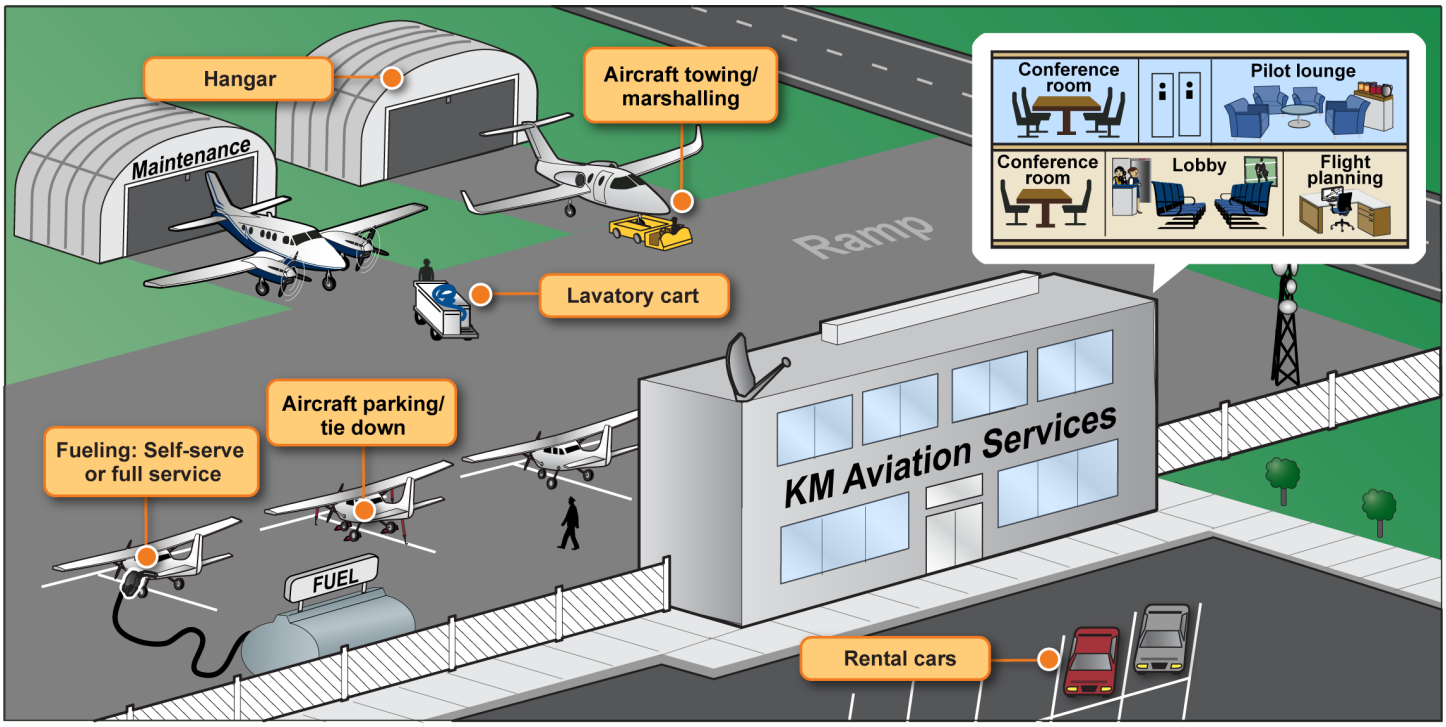
Background

What is an FBO?

FAA defines an FBO as a business granted the right by the airport to operate fueling facilities, hangars, aircraft tie-downs, aircraft rental, aircraft maintenance, flight instruction, and other aeronautical services at an airport.[8] In addition, FBOs sometimes manage parking ramps for transient aircraft at the airport. FBOs may charge a fee for parking, as they also maintain the ramp areas for the airport. According to FAA, airports, within certain parameters, have the ability to charge or not to charge users for access to airport ramp space. FBOs generally serve pilots who operate general aviation aircraft, but can also support commercial flights. The type of amenities and services any one FBO provides varies. For example, representatives of one FBO said that it provides high-level customer service and offers more services such as catering, pilot lounges, concierge services, and aircraft maintenance and repair facilities for its clients. See figure 1 for an illustration of FBO services.

[8] General aviation aircraft use two types of aviation fuel that are generally sold at FBOs—Jet A and 100 Low lead (100LL). Jet and turbine aircraft use Jet A fuel while piston aircraft use 100LL fuel.

Figure 1: Illustration of Services of Fixed Base Operators at Airports



Source: GAO. | GAO-20-16

As of March 2019, we identified 3,070 FBOs operating at 3,016 airports located in the contiguous United States; these airports are included in FAA's National Plan of Integrated Airport Systems (NPIAS).[9] FBOs can be run by the airport, an independent operator, or a network chain with multiple locations. The Transportation Research Board estimated in 2016 that 47 percent of all FBO locations were airport-operated.[10]

Most stakeholders with whom we spoke agreed that there are fewer FBOs today than in the past, although estimates vary on the extent of the

[9] The FAA's NPIAS identifies airports that are significant to national air transportation and therefore eligible to receive grants under the FAA's Airport Improvement Program (AIP).

[10] Transportation Research Board, Airport Cooperative Research Program, Synthesis 86. *Airport Operator Options for Delivery of FBO Services: A Synthesis of Airport Practice* (Washington, D.C.: 2018).

decline in FBO numbers.[11] Stakeholders we interviewed said that this decline is due to factors such as a drop in general aviation activity that resulted in a reduction in fuel sales. More recent innovations, such as more fuel-efficient aircraft and decision-making software that provides information to pilots on where to purchase fuel to fly more efficiently, also contributed to the decline.[12]

Airport and Federal Oversight of FBO Activities

Airports that receive federal AIP grants contractually agree to FAA "grant assurances" that require those airports to adhere to certain requirements.[13] One of those key grant assurances is a prohibition of unjust economic discrimination. This assurance requires airports to provide to users equal access to airport facilities. Likewise, tenant businesses (e.g. FBOs) operating at airports are required to make services available and price those services not in an unduly discriminatory fashion.[14] Although FAA is required to ensure that airports, as a condition for accepting federal grants, provide fair and equal access to services and nondiscriminatory pricing, FAA does not regulate prices in the FBO industry. As a condition of accepting federal grants, airports have a responsibility to ensure that they and their contractors and concessionaires abide by the grant assurances. FAA's Airport Compliance Office oversees airports' adherence to grant assurances by taking and responding to inquiries and complaints, developing and

[11] Transportation Research Board, Airport Cooperative Research Program, Legal Research Digest 37. *Legal Issues Relating to Airports Promoting Competition* (Washington D.C.: June 2019).

[12] Transportation Research Board, Airport Cooperative Research Program, Synthesis 86. *Airport Operator Options for Delivery of FBO Services: A Synthesis of Airport Practice* (Washington, D.C.: 2018).

[13] The FAA administers the AIP, which provides billions of dollars in federal grants to airports for airport planning and development projects.

[14] FAA Grant Assurance 22 states that, among other things, the airport will be made available for public use on reasonable terms and without unjust discrimination to all types, kinds, and classes of aeronautical activities, including commercial aeronautical activities providing services to the public. Further, it states that in leases or contracts granting access to the airport for aeronautical activities for furnishing services to the public at the airport, the airport sponsor shall include and enforce requirements that the contract holder (1) furnishes its services on a reasonable, and not unjustly discriminatory, basis, and (2) charges reasonable, and not unjustly discriminatory, prices for each unit or service, provided that the contractor may make reasonable and not unjustly discriminatory discounts or other types of price reductions for volume purchasers. 49 U.S.C. § 47107 (a) (1).

circulating advisories and guidance documents, and coordinating with airports and industry to conduct compliance training and airport land use inspections.[15]

The Department of Justice (DOJ) also plays a role in overseeing the FBO industry under its antitrust responsibilities to preserve competition.[16] For example, in the Final Judgement entered by a federal court in the DOJ's case regarding the acquisition by BBA Aviation (Signature Flight Support) acquisition of Landmark Aviation, BBA was required to divest FBO facilities in six locations where the transaction would have created a monopoly or duopoly for FBO services. In addition, the court order required BBA to provide advance notice of certain future acquisitions for the 10-year duration of the final judgment.[17]

Transparency of FBO Fees Varies by Service

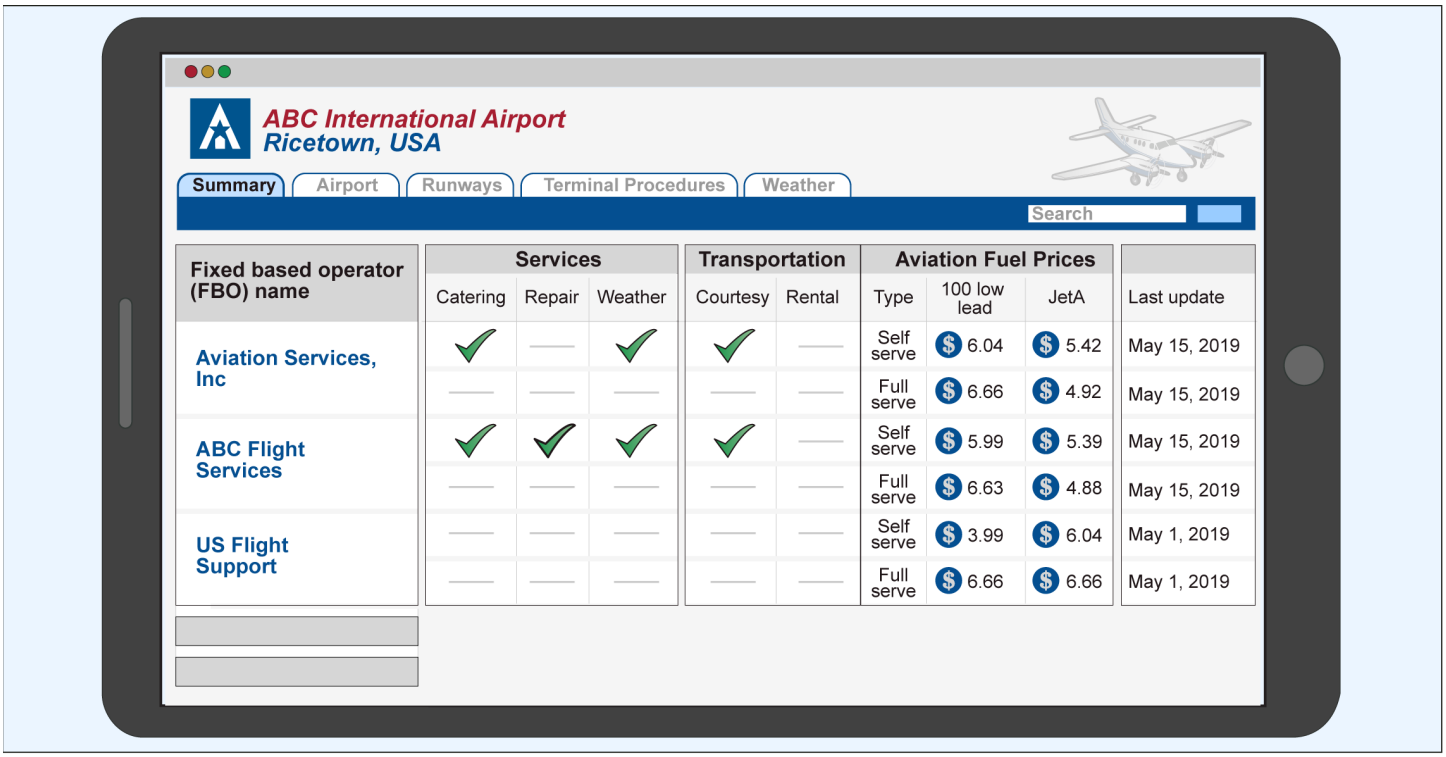
Based on our review of FBO and third party websites, we found that fuel prices at FBOs are readily available to anyone on the internet. Nearly all of the pilots we spoke with told us they use these resources for making flight plans. For example, current prices for fuel are readily available on third party websites such as AirNav and Sky Vector, among others, and on about a third of the websites for FBOs we visited. See figure 2 for a representation of a website providing FBO information.

[15] FAA's Office of Airports includes 9 regional offices and 21 airport district offices.

[16] The Department of Justice is responsible for examining potential adverse competitive effects of mergers, such as whether the merged entity will be able to charge higher prices or restrict output for the product or service it sells. Clayton Act § 7A (Hart-Scott-Rodino Antitrust Improvements Act of 1976), 15 U.S.C. § 18a).

[17] United States v. BBA Aviation PLC (Signature Flight Support), Civil Action No. 16-0174 (D.D.C. -2016).

Figure 2: Representation of a Website Showing FBO Services



Source: GAO. | GAO-20-16

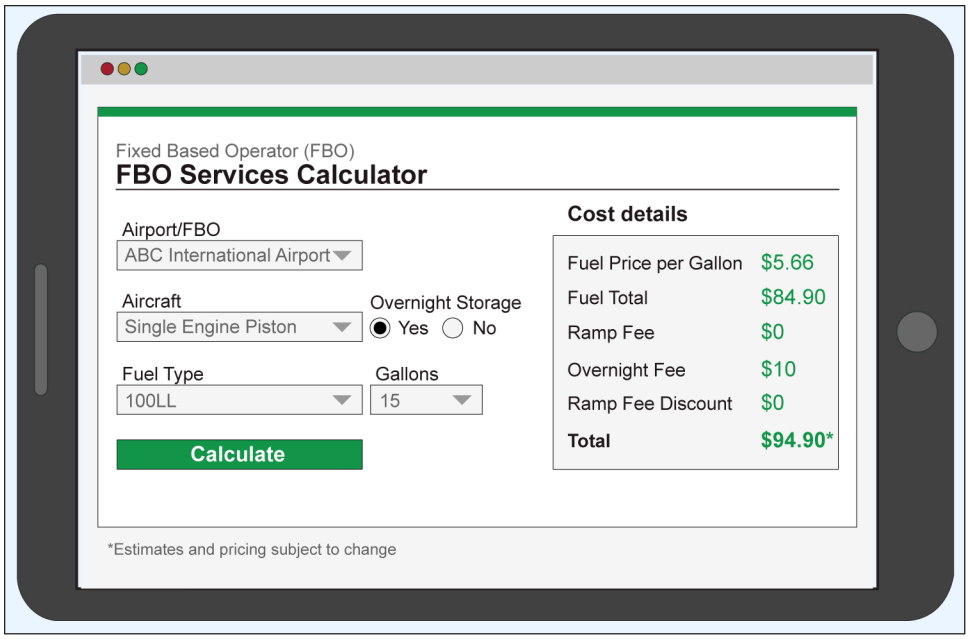
However, fees for other services such as for parking and aircraft handling are less transparent. Our review of FBO and third-party websites found that such fees are not always available online, and that fees may vary by type of aircraft, are sometimes waived, and are called by different terms. According to FBO staff we spoke with, fees for services other than fueling can be lengthy and unwieldy to post on their websites for multiple reasons. First, some fees will vary based on the size and approved weight of the aircraft. For example, the price sheet for services other than fuel at one FBO showed fees varying by the aircraft's approved weight, so there were 11 different prices for each of those services. The same pricing sheet also included prices for dozens of incidental services, such as aircraft towing and lavatory service that are not based on aircraft weight. Additionally, customers may be eligible for discounts on fuel purchases either by volume or through a membership program. FBOs may also waive fees in some cases—for example, with a qualifying fuel purchase an FBO might waive a parking, ramp, or handling fee. Further, a few stakeholders and pilots we spoke to indicated that FBOs don't always

use the same terms for a fee. For example, a landing fee or a ramp fee might be a fee for doing essentially the same thing. Consequently, to find out how much an FBO visit will cost, 16 of the 18 pilots we interviewed told us they call the FBO in advance. Based on information such as their type of aircraft, length of stay, and other services they might require, the FBO provides an estimate of their total cost.

Recently, some industry stakeholders have called for increased price transparency and consistency among FBOs regarding how they characterize their fees, and have taken some actions to increase the transparency of fees. A campaign called, "Know Before You Go," developed through the cooperation of six aviation associations, encourages FBOs to communicate and expeditiously provide available services and a listing of currently applicable posted fuel prices, as well as fees and charges for other available services.[18] Further, the campaign suggests that these fees and charges should be made accessible to aircraft operators online in a user friendly manner and with sufficient clarity. Additionally, it encourages customers to contact the FBO to ask questions so pilots can make informed decisions. In response, one large-chain FBO began posting fees online for piston aircraft at its locations and another FBO company created a trip calculator on its web site for pilots to calculate the cost of their visit (see fig 3). We also found that a third party company recently began a web site that provides FBO parking ramp fees similar to those providing fuel prices. In addition, AOPA invited FBOs to include their fees in the association's online airport directory. The association also indicated it categorizes the variety of fees into basic types of fees such as landing, using a hanger, or using lavatory service to help clarify what pilots could be expected to pay. In October 2019, AOPA officials indicated that FBOs' posting of fees had not increased as much as they hoped.

[18] The "Know Before You Go" effort was developed by the Aircraft Owners and Pilots Association, Experimental Aircraft Association, General Aviation Manufacturers Association, Helicopter International Association, National Air Transportation Association, and the National Business Aviation Association.

Figure 3: Representation of an FBO Website Calculator for Fees



Source: GAO. | GAO-20-16

Various Cost and Demand Factors and the Extent of Competition Are Associated with FBO Prices

Selected stakeholders we interviewed—including officials from 26 airports, 16 FBOs, as well as 18 general aviation pilots—highlighted key factors that may influence FBO prices at airports across the country. Our statistical model confirmed a correlation between certain key factors identified by stakeholders and FBO prices. Consistent with general economic theory, these factors fall into three groups: (1) an FBO's costs, (2) demand for an FBO's services, and (3) competition among FBOs.

Stakeholders Reported That Cost Factors May Influence Prices

Selected stakeholders we interviewed highlighted cost factors such as airport leases, infrastructure investment, fuel, labor, and security as influencing FBO prices. They cited the following examples:

- **Airport Leases.** Airport leases dictate terms and conditions of contracts between an FBO and an airport and include provisions related to the services an FBO must provide for pilots. Depending on

the specific requirements or minimum standards developed at a given airport, FBO lease requirements vary and can affect an FBO's costs.[19] For example, at one airport we visited, the FBO is required to offer an after-hours self-service fueling option, which necessitates the acquisition and maintenance of additional equipment. In another case, the manager at an FBO we spoke to said that its overhead costs are relatively high because it is required to offer flight training and aircraft maintenance as part of its lease. To offer these services the FBO needs additional hangar space and must pay qualified skilled employees.

- **Infrastructure Investment.** As with leasing costs, the greater the investment an FBO makes at an airport, the higher its prices to users may be. According to airport and interest group officials we spoke with, FBOs typically have 20 to 30 year leases during which they may make infrastructure investments such as building hangars or lounges, based on FBO's assessment of customer demand for its services. For example, according to airport and FBO officials we spoke to, an FBO will choose to invest in high-end facilities and amenities if it determines there is sufficient demand and revenues earned are expected to be sufficient to recoup the costs over the term of the lease.
- **Fuel Transportation Costs.** FBOs generally sell two types of aviation fuel for general aviation aircraft: Jet A and 100 low lead (100LL). Jet A is generally delivered over long distances via pipeline. According to one petroleum company, 100LL is generally moved by truck, rail, or barge—less cost-effective methods of transport than pipeline—due to the smaller volumes being produced. Further, there are parts of the United States, specifically on the East Coast, where little or no 100LL is produced and, as a result, transportation costs can significantly affect the cost of fuel to the FBO.
- **Labor costs.** FBOs compete in the local labor market for staff. The cost of labor for FBOs may vary across local labor markets around the country. Further, a particular FBO may need specialized skills to

[19] According to FAA, airport minimum standards are established by an airport sponsor to ensure a safe, efficient and adequate level of operation and services is offered to the public. Standards must be reasonable and not unjustly discriminatory. In exchange for engaging in commercial aeronautical activity at an airport, a service provider agrees to comply with airport minimum standards. Minimum standards are not mandatory, and FAA recommends that these standards be made part of any lease agreement. See, FAA, *Minimum Standards for Commercial Aeronautical Activities*, Advisory Circular No. 150/5190-7, (Washington, D.C., Aug. 28, 2006) and FAA, *Airport Compliance Manual* Order 5190.6B—"Chapter 10" (Washington, D.C., Sept. 30, 2009).

provide the services they offer, and this factor can affect the FBO's costs. For example, some FBOs offer maintenance services, so will have trained mechanics on staff to perform such services.

- **State taxes.** Aviation fuel excise taxes on 100LL vary considerably from state to state and may also affect the costs to a consumer. For example, both Oregon and Idaho have a lower state aviation fuel tax compared to neighboring Washington State. An FBO manager told us that in some cases, a pilot will fly over to Idaho to obtain less expensive fuel, even though he or she may base the aircraft in Washington.
- **Security.** Some airports—particularly those with commercial service—are responsible for implementing security requirements in accordance with their Transportation Security Administration (TSA)-approved security programs, notably the security of perimeters and access controls protecting restricted areas of the airport, such as ramps and taxiways.[20] We found that some FBOs are responsible for security and access controls on their leased property based on our review of individual lease requirements and the airport security plan. These FBOs might require staff on site 24 hours a day to maintain airfield and perimeter security, a requirement that can increase FBO costs. For example, an FBO operating at an airport with commercial service told us that it is responsible for perimeter security on the land it leases from the airport. In addition, it is subject to unannounced security checks by TSA. In contrast, smaller general aviation airports without commercial service are not required to have as many security requirements.

Stakeholders Said Demand Factors May Influence Prices

Selected stakeholders told us that the location of an airport may influence demand for FBO services. Economic theory indicates that increased demand for a service will generally result in increased prices, all else equal. In particular, stakeholders cited the following examples of demand factors that may influence prices:

- Busy and congested airports may have higher prices for FBO services due to greater demand.
- Prices may be higher during part of the year in locations with significant seasonal traffic, such as beach resorts with a summer high

[20] 49 C.F.R. Part 1542 specifies generally that commercial service airports are subject to special security requirements. According to TSA guidance issued in July 2017, strictly general aviation airports do not have to meet these same security requirements.

season and ski resorts with a winter high season. The increased demand at FBOs during high seasons results in higher prices than during the off season.

- An airport's proximity to the central business district may be associated with higher demand and higher prices in such locations.

Stakeholders Described How the Extent of Competition May Influence FBO Prices

In addition to cost and demand factors, the extent to which the market for FBO services is competitive may also influence prices.[21] According to the stakeholders we interviewed, competition among FBOs may lead to lower prices than would be the case when only one FBO provides the service at that airport. In our analysis of FAA airport and FBO data, however, we found that nearly 90 percent of NPIAS airports that offer FBO services are served by only one FBO (see table 1). According to a Transportation Research Board report, a strong indicator of the number of FBOs that can be financially viable at an airport can be the amount of fuel sales. For example, two airport managers we spoke to said that there was an insufficient volume of fuel sold at their airports to support more than one FBO.

Table 1: Fixed Base Operator (FBO) population at NPIAS airports in the Contiguous United States with at least One FBO

Number of FBOs at airport	Number of airports	Percentage of airports with FBOs
1 FBO	2418	89.9%
2 FBOs	203	7.5%
3 or more FBOs	69	2.6%

Source: GAO analysis of Federal Aviation Administration (FAA) NPIAS and fixed base operator fuel price data. | GAO-20-16

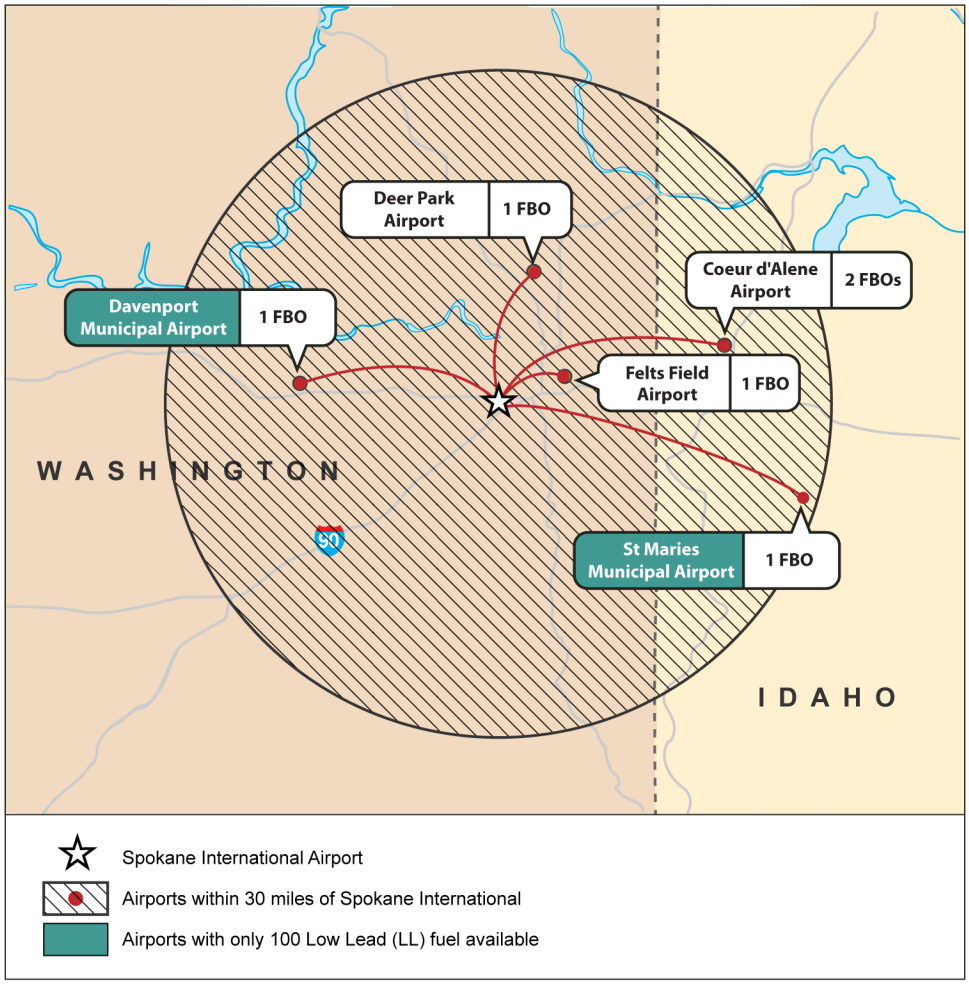
Notes: Percentages are based on the total number of airports with at least one FBO (2,690). We identified 326 NPIAS airports in FAA's National Plan of Integrated Airport Systems (NPIAS)—public use airports eligible for federal investment funding—without a fixed base operator (FBO). We counted FBOs separately at the airport regardless of same ownership. We excluded heliports, seaplane bases and future airports from our analysis.

While the majority of NPIAS airports in the contiguous United States have only one FBO, pilots we spoke to said that competition from FBOs at nearby airports can also affect prices. For example, within 30 miles of Spokane International Airport, there are five other airports, each of which

[21] Economic theory suggests that prices are generally lower when consumers have more substitutes from which to choose. By contrast, when substitutes are more limited, prices can persist at a higher level than they would in a more competitive market.

is served by an FBO that may compete with the services provided at Spokane International. (See fig. 4)

Figure 4: FBOs at Airports within 30 Miles of Spokane International Airport



Source: GAO analysis of FAA and Fixed Base Operator (FBO) information. | GAO-20-16

We asked selected managers of FBOs and airports and selected general aviation pilots to describe how off-airport competition may influence FBO pricing. FBO and airport managers told us that they view nearby airports as competitors and monitor the FBO prices at these locations. For example, an FBO manager in Maine told us he regularly checks the prices at the larger international airport that is nearby. This finding suggests that when an FBO sets its prices, it takes into account the

extent to which nearby airports may compete for its services. On the buyer's side of the market, 11 of the 18 general aviation pilots we interviewed told us that they generally "price shop" for aviation fuel. Further, most general aviation pilots we spoke with told us they use online flight-planning tools to map their route and consider the fuel cost and service fees of the airports along that route. Further, four pilots and an FBO manager indicated that on longer trips that require refueling before reaching a destination, pilots may have options that are hundreds of miles from each other. For example, when flying from California to Texas, a pilot could choose to stop either in New Mexico or Arizona to obtain fuel. In this scenario, a pilot would compare prices of many FBOs in those two states and likely choose one with lower fuel prices. Likewise, an FBO manager in Kansas indicated that for these types of customers, he competes with FBOs at airports more than 100 miles away.

However, we interviewed some pilots who said that they do not consider every nearby airport as a substitute. To be a true substitute the airport must meet the pilot's needs to be a viable option. For example, the airport's runway must be of sufficient length for the aircraft, and some runways may be too short for certain aircraft. Also, pilots take into account the type of fuel offered at an FBO. The pilot of a piston-driven aircraft will be unable to refuel at an FBO that offers only jet fuel. Finally, some pilots said the price differential would need to be sufficiently large to compensate them for any inconvenience. Some mentioned that the price of 100LL would have to be 30 to 40 cents per gallon lower to affect their flight plan, while others put that threshold at a lower point, 25 to 30 cents per gallon. Pilots also told us they take travel time into account. For example, some pilots said that they would consider landing at an alternative airport with lower prices if it were no more than 20 to 30 miles out of their way and if the change in destination were to add no more than 10 to 20 minutes to their trip.

As a first step in examining the relationship of FBO competition with pricing, we examined differences in the average posted prices for 100LL and Jet A across NPIAS airports in the contiguous United States where only one FBO sold a fuel type compared to airports at which more than one FBO sold that fuel, without controlling for other factors that might also

be correlated with prices.[22] We also calculated the average prices at airports with one FBO and airports with multiple FBOs for a subset of airports with an air traffic control tower. We examined this subset of towered-airports, as they generally have more operations, and thus more demand.[23] As shown in table 2 below, the average price per gallon of aviation fuel was lower at airports with only one FBO than at airports with on-airport competition.[24] For example, at airports with only one FBO, the average price posted for full-service 100LL was $5.01 per gallon, while the average price posted at airports with more than one FBO was about 73 cents higher.

Table 2: Airport Average Price per Gallon of Aviation Fuels at Selected NPIAS Airports with and without On-Airport Competition

	NPIAS airports[a]		Towered NPIAS airports[b]	
Fuel type	Airports' with on-airport competition	Airports without on-airport competition	Airports with on-airport competition	Airports without on-airport competition
100 low lead	$5.74	$5.01	$5.84	$5.59
Jet A	$5.37	$4.80	$5.44	$5.43

Source: GAO analysis of fuel price data. | GAO-20-16

Note: Prices are net of state sales and excise taxes. The fuel price data we obtained reported prices at 1,581 National Plan of Integrated Airport Systems (NPIAS) airports with full-service 100 Low Lead (100LL) and 956 airports where full-service Jet A is sold in the contiguous United States. For airports with on-airport competition, we first calculated the average price posted by all fixed base operators at each airport. We then found the average of these prices across all airports with on-airport competition.

[a]Among NPIAS airports in our data on fuel prices, only one FBO was selling 100LL at 1380 airports, and more than one FBO was selling 100LL at 201 airports and only one FBO was selling Jet A at 799 airports, and more than one FBO was selling Jet A at 157 airports.

[b]Among NPIAS airports with air traffic control towers in our data on fuel prices, only one FBO was selling 100LL at 357 airports, and more than one FBO was selling 100LL at 171 airports and only one FBO was selling Jet A at 280 airports, and more than one FBO was selling 100LL at 142 airports.

[22]All fuel price data are the posted price. That is, these prices are not reflective of discounts that may be provided to purchasers based on special contracts or buyers' club deals. Based on our audit work, such discounts are more common in the sale of Jet A fuel than for 100LL. Despite this limitation, we believe the data we obtained are sufficiently reliable for our purposes.

[23] We also found that with more demand, such airports are more likely to have more than one FBO. Thus, the towered-airports dataset provided a greater degree of variation in on-airport competition.

[24] Because the purpose of this analysis is to focus on the cost, demand, and competitive factors that correlate with fuel prices, we subtracted state taxes from reported fuel prices to develop the price variable used in the model.

However, examining average differences in price fails to control for other factors that might be correlated with prices. In particular, airports that have more than one FBO are likely to be those that have higher traffic volumes and that are located in areas with larger populations and higher per-capita incomes—all factors likely correlated with higher prices. Therefore, to more fully assess the issue, we developed a statistical model that examines how fuel prices may be correlated with measures of competition when controlling for other factors, such as demand, that also may be correlated with prices.

Our Statistical Model Indicates Several Factors Are Correlated with FBO Fuel Prices

Our statistical model confirmed a correlation between selected cost and demand factors and FBO-posted pricing of full-service 100LL and Jet A. It also confirmed a correlation between some of the competition factors described by stakeholders and the price of aviation fuel. Our analysis included information on posted prices for both 100LL as well as Jet A. In addition to running the model for NPIAS airports in the contiguous United States for which posted prices were available (all-airports), we also ran the model for a subset of these airports that have air traffic control towers (towered-airports). See appendix II for a more detailed discussion of the model structure and findings.

As we have noted, we expected fuel prices to be correlated with a variety of cost, demand, and competition factors that pertain to characteristics of airports and their locations, as well as characteristics of FBOs operating at airports. We found the following correlations:

- **Airport Characteristics.**[25] Our model found that the size of an airport—measured as the total number of operations—was associated with higher prices for both 100LL and Jet A. The operational size of an airport is likely associated with higher demand for airport services and also is likely related to higher costs of providing those services. Specifically, we found that an increase of 10,000 airport operations per year was associated with higher prices of about 2 cents per gallon for both 100LL and Jet A in both the all-airports and towered-airports datasets. The length of the longest runway available at an airport was also correlated with higher fuel prices. The length of the runway is an indicator of the types of aircraft an airport can support. In particular, longer runways are able to accommodate larger and heavier aircraft—aircraft that generally use more fuel and thus may indicate higher

[25] We did not control for airport ownership of FBOs because such data were unavailable.

demand for fuel at the airport. Specifically, we found that a 1,000-foot increase in runway length was associated with a higher price of about 7 to 8 cents per gallon for both fuels.

- **Demographic Characteristics of Airport Location.** Our analysis found that FBOs' fuel prices were generally higher at airports in areas with higher incomes, but not always at airports in areas with larger population. We found that prices for both types of fuel were higher at airports located in counties with higher per-capita incomes. Where incomes are higher, we would expect the demand for travel to be greater. Moreover, where there are higher incomes, the cost of providing FBO services—particularly labor costs—are likely higher.[26] We found income correlated with fuel prices for both the 100LL and Jet A in the all-airports datasets and for 100LL in the towered-only airport dataset. We also found that 100LL aviation fuel prices were higher at airports located in counties with larger populations. This was expected due to the likely greater demand for air travel in more populous areas. However, county population was not statistically significant in relation to the price of Jet A.[27]
- **Geographic Characteristics of Airport.** Our model found that airports located in states on the East Coast tend to have higher 100LL prices.[28] Specifically, the model suggests that 100LL prices are between 22 to 26 cents higher per gallon on average in these states.[29] We expected FBOs operating in East Coast states to have higher 100LL prices due to higher transportation costs, as we found that there is no production of 100LL in these states. As mentioned earlier, 100LL is generally moved by truck, rail or barge due to the smaller volumes being produced—a less cost-effective means of transport than pipeline. Jet A, on the other hand, is transported by pipeline over long distances.[30] We thus expected higher prices for

[26] To account for the possibility of a nonlinear relationship between income and fuel prices, we included a variable equal to the square of personal income per capita.

[27] In the towered-airport dataset, the estimated effect was statistically significant but relatively small, at less than one cent per additional 100,000 in county population.

[28] East Coast states here refers to Connecticut, Delaware, Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, and West Virginia.

[29] Specifically, prices appear to be about 22 cents higher in East Coast states in the all-airports dataset, and about 25 to 26 cents higher in the towered-airport dataset.

[30] Because Jet A is typically transported over longer distances by pipeline, we did not control for location on the East Coast in our specifications analyzing Jet A prices.

100LL at airports in these states. We found this geographic differential in all specifications for the 100LL model.

- **Large-Chain FBOs.** Our model found that both types of fuel tend to have higher posted prices at airports that have a large-chain FBO operating on the premises, regardless of whether or not there was another competitor on the premises.[31] Specifically we found that when a large-chain FBO operates at an airport, fuel at the airport tends to be more expensive on average—on the order of 60 cents more per gallon for 100LL, and an even greater differential for Jet A, more than $1.20 per gallon.[32]
- **Availability of Self-Serve 100LL fuel.** Our model found that when self-serve 100LL is available at an airport, the prices for full-serve 100LL tend to be lower than at airports with no self-serve 100LL available. Specifically, we found that if a self-serve 100LL option is available at an airport, the price of full-service 100LL will be about 10.5 cents per gallon lower, on average, compared to FBOs at airports without self-service 100LL. We expected a self-service option might be correlated with somewhat lower prices for full service 100LL—even if the full service option is provided by the same FBO—because pilots are presented with a lower price option may constrain the prices that FBOs will charge for a full-service option.
- **Competition.** Within our statistical model, we examined whether the extent of competition among FBOs had a correlation with fuel pricing in two ways.
  - *On-airport competition*. On-airport competition occurs when two or more FBOs at an airport sell the same kind of fuel.

    We estimated that the price of Jet A is lower, on average, at an airport when two or more FBOs provided that fuel at an airport. Specifically, for the all-airports dataset, we found that, on average, the posted price of Jet A was 35 cents per gallon higher if only one FBO sold the fuel at an airport compared to the case when at least one additional competitor also served the airport. In the towered-airports dataset, the posted price of Jet A was about 50

[31] For the purposes of the model we included a variable to account for an FBO as a "large-chain" if it has at least 25 FBOs around the country under their company name.

[32] This factor was statistically different from zero for both 100LL and Jet A in both the all-airports and the towered-airports datasets.

cents higher on average if there were only one FBO at the airport.[33]

For 100LL, we did not find a statistical relationship between on-airport competition and prices in the all-airports dataset; however, we did find a statistical relationship between on-airport competition and prices in the towered-airports dataset. The finding of no correlation between on-airport competition and 100LL prices may be linked to the rarity of airports with more than one FBO selling 100LL in the all-airports dataset. In fact, in the all-airports dataset, only 13 percent of FBOs faced on-airport competition in the sale of 100LL while in the towered-airports dataset about one-third of FBOs faced competition in the sale of 100LL. Specifically, we estimated that the price of 100LL is 11 cents lower, on average, if there are at least two FBOs selling that fuel at a towered airport.[34]

- *Nearby competition*. Our model also tested whether the availability of additional FBOs at airports within a 30-mile distance from a given airport had any correlation to prices for 100LL. We included this factor because many of the stakeholders we spoke to noted that general aviation pilots will consider using an airport near their preferred airport if prices were more favorable at the alternative location. However, across all model specifications, we did not find that prices for 100LL were correlated with the presence of FBOs at nearby airports.

[33] These effects are statistically different from zero. On-airport competition in the Jet A model was statistically significant at the 1 percent level.

[34] In the towered-airports dataset, on-airport competition has an effect on 100LL prices that was statistically different from zero.

FAA's Compliance Activities Have Not Identified FBO Pricing as a Widespread Area of Concern, and FAA Is Taking Steps to Consolidate and Review Regional Inquiries

FAA officials told us they primarily rely on airports to self-certify their compliance with federal airport grant assurances when they accept AIP grant funding. This reliance includes the grant assurance that relates to FBO fees—an airport must ensure aeronautical services are available to all users on a reasonable and not unjustly discriminatory basis. FAA officials indicated that airport compliance staff conduct outreach to stakeholders and provide training aimed at ensuring that airports comply with these assurances. One recent outreach effort focused on FBO pricing. Additionally, FAA responds to phone and email inquiries and informal and formal complaints, and conducts periodic airport land use inspections, as discussed below, but none of these efforts has identified FBO pricing as a widespread area of concern.

Training and Outreach. According to FAA, compliance staff conducts periodic training and outreach to the airport community on a variety of compliance issues. FAA headquarters annually conducts recurrent compliance training—which includes overseeing airport grant assurances—with regional and other FAA offices. FAA officials told us they use these sessions to address concerns brought up by regional compliance officials and airport compliance staff. One example of FAA's outreach efforts occurred in December 2017 after AOPA raised questions about FBO pricing earlier that year. To bring clarity to the issue of FBO pricing and the role of FAA, the agency released questions and answers that emphasized: (1) FAA does not regulate FBO prices; and (2) airports are responsible for ensuring FBO prices are reasonable and applied in a non-unjustly discriminatory manner. Furthermore, FAA stated that whether an FBO's fees are reasonable (i.e., higher than average than other FBOs) involves a number of economic, business, and other factors that vary widely from airport to airport and FBO to FBO and may include underlying costs, market conditions, quality of service, and other factors.

Inquiries and Complaints. According to FAA, airport compliance staff respond to (1) phone and e-mail inquiries, (2) informal complaints, and (3) formal complaints. FAA officials told us that, while FAA does not regulate FBO prices, if someone contacts them with inquiries or a concern about a potential grant assurance violation, such as one involving FBO prices, they first refer the issue to the local airport to resolve. If the issue is not resolved, the complainant may file an informal complaint with an FAA regional office.[35] According to FAA guidance, each FAA regional office

[35] Informal complaint procedures are outlined in 14 C.F.R. Part 13 and formal complaint procedures are in Part 16.

will review the complaint and issue a letter indicating whether FAA sees a grant violation that the airport should fix or not. If the complainant is dissatisfied with the regional office's letter, the complainant may then file a formal complaint about a violation of grant assurances with headquarters. Headquarters will then review the circumstances of the complaint and make a formal determination as to whether a grant violation occurred and work with the airport to address the violation.

Data on informal and formal complaints filed with FAA headquarters and regional offices indicate FAA has not received many complaints on FBO pricing. Specifically, we reviewed informal complaint data from 2013 through 2018 from each FAA region, and found a total of 142 informal complaints about potential grant violations. Seven of these complaints related to FBO prices, and FAA found one violation later resolved by the airport by providing space for aircraft to do routine maintenance. In addition, we obtained and reviewed FAA's responses to formal complaints from 2013 through 2018, and found that none of these formal complaint responses dealt with FBO prices. While FAA received few complaints related to FBO prices, there are limitations in relying on complaint data to understand the magnitude of an issue. For example, some pilots we spoke with stated if they have an issue with an FBO, they will use an alternative FBO rather than submit a complaint to FAA.

We found that in addition to informal and formal complaints, each FAA regional office independently records inquiries about airport grant assurance issues ranging from inappropriate hanger use to noise complaints to FBO lease arrangements. Further, each region varies in the way it captures airport compliance information such as airport location, dates, and description of an inquiry or concern. For example, some regions indicate the specific grant assurance that was potentially violated while others simply describe the nature of the concern. To help see if there is a pattern of concerns across the country, FAA's Office of Airport Compliance in headquarters has an initiative to centralize information on inquiries and concerns about grant assurances, including any that may be related to FBO prices. As envisioned, this "Enhanced Information Sharing Initiative" will provide FAA compliance staff with the ability to record and track inquires and complaints in comparable systems and should facilitate information sharing among regions and between regions and headquarters. According to FAA officials, centralizing this information will help identify issues that may be of a concern to airport users. According to FAA officials, this initiative, originally planned to be completed in August 2019, has faced delays due to a government shutdown earlier this year and information technology security difficulties. However, FAA has

hired a new contractor and anticipates completion sometime in fiscal year 2020. According to an FAA compliance manager, problems that arise in the regions are brought to the attention of the airport compliance offices and discussed, and whether additional actions should be taken.

Airport Land-Use Inspections. FAA is required to conduct a minimum of two airport land-use inspections per year per region, reviewing whether airports are complying with grant assurances such as airport property use requirements and lease agreements. We reviewed FAA's annual land use inspection reports to Congress from fiscal year 2013 through 2018 and did not identify any FBO pricing concerns.

Agency Comments

We provided a draft of this report to DOJ and DOT for review and comment. DOJ provided technical comments, which we incorporated as appropriate. DOJ also suggested that we discuss more directly the implications that airport ownership of FBOs might have for fuel prices. We agree that airport-owned FBOs might price fuel differently than privately-owned FBOs. However, we were not able to obtain reliable data on airport ownership of FBOs. DOT did not have any comments.

We are sending copies of this report to the appropriate congressional committees, the Secretary of the Department of Transportation, the Attorney General, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov

If you or your staff any have questions about this report, please contact me at (202) 512-2834 or VonahA@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Sincerely yours,

Andrew Von Ah
Director, Physical Infrastructure Issues

Appendix I: Airports and Fixed Base Operators GAO Interviewed

Table 3: Airports and Fixed Base Operators Interviewed by GAO

Airport	Location
Laughlin-Bullhead International	Bullhead City, AZ
Rocky Mountain Metropolitan	Broomfield, CO
Coeur d'Alene – Pappy Boyington Field	Hayden, ID
Waukegan National	Waukegan, IL
Lawrence Municipal	Lawrence, KS
New Century Air Center	Olathe, KS
Johnson County Executive	Olathe, KS
Philip Billard Municipal	Topeka, KS
Topeka Regional	Topeka, KS
Bangor International	Bangor, ME
Knox County Regional	Owls Head, ME
Hancock County Bar Harbor	Trenton, ME
Rochester International	Rochester, MN
Sloulin Field	Williston, ND
Atlantic City International	Atlantic City, NJ
Boulder City Municipal	Boulder City, NV
North Las Vegas	Las Vegas, NV
Arnold Palmer Regional	Latrobe, PA
Hilton Head Island	Hilton Head, SC
Charlottesville-Albemarle	Charlottesville, VA
Norfolk International	Norfolk, VA
Davenport Municipal	Davenport, WA
Deer Park Municipal	Deer Park, WA
Renton Municipal	Renton, WA
Felts Field	Spokane, WA
Spokane International	Spokane, WA

Fixed Base Operators	Airport
Signature Flight Support	Laughlin-Bullhead International
Resort Jet Center	Coeur d' Alene – Pappy Boyington Field
Hetrick Air Services	Lawrence Municipal
Air Associates of Kansas	Johnson County Executive
Kaw Valley Aviation	Philip Billard Municipal
Million Air Topeka	Topeka Regional
Bangor Airport Services	Bangor International

Columbia Air Services	Hancock County Bar Harbor
Downeast Air	Knox County Regional
Boulder City Aviation Services	Boulder City Municipal
B.F.E. LLC	Boulder City Municipal
Clark County Department of Aviation	North Las Vegas
City of Davenport	Davenport Municipal
Deer Park Airport	Deer Park Municipal
Western Aviation	Felts Field
Signature Flight Support	Spokane International

Source: GAO. | GAO-20-16

Appendix II: Analysis of Factors Associated with Aviation Fuel Prices

This appendix describes a model we developed to assess factors that may correlate with fixed base operator (FBO) aviation fuel prices across airports. The model uses data on posted prices for full-service 100LL aviation fuel (100LL) and Jet A (Jet A) fuel at a sample of airports in the contiguous United States that are part of the National Plan of Integrated Airport Systems (NPIAS), along with data on selected other factors that may be correlated with fuel prices. Specifically, this appendix discusses (1) the structure of the model, data sources, and variable definitions, and (2) base-case and alternative model results.

Structure of Model, Data Sources, and Variable Definitions

Based on our audit work as well as economic reasoning, we hypothesized that a variety of factors may be correlated with aviation fuel prices across airports. Generally, factors that influence the price of any product are the demand for the product, the cost of producing and marketing the product, and the extent of competition among those selling the product. To examine the correlation between these factors and the price of both 100LL and Jet A fuel sold by FBOs, we developed an econometric model. Specifically, our model analyzed the independent correlation of selected key factors with aviation fuel prices.[1] We used several specifications of the model for both full-service 100LL and full-service Jet A.

Each specification used airport-level data to analyze variation in the price of a single type of fuel across airports. For each type of fuel, we included only NPIAS airports within the contiguous United States for which our data on aviation fuel prices reported a price for at least one FBO.[2] In addition, we ran the analysis not only on the full dataset of all of the airports for which we were able to obtain fuel-pricing information (which

[1] We use an ordinary least squares regression model.

[2] The National Plan of Integrated Airports (NPIAS) includes airports that are eligible to receive federal support for airport infrastructure in the form of Airport Improvement Program (AIP) grants. Data on FBO prices for aviation fuel by airport were obtained from a vendor that maintains a publicly accessible website on FBO fuel prices. Although there are more than 3,000 NPIAS airports, the fuel data we obtained reported prices for 1,581 NPIAS airports where full-service 100LL is sold and 956 NPIAS airports where full-service Jet A is sold.

we refer to as the all-airports dataset), but also on a subset of airports limited to those with an air traffic control tower (towered-airports dataset).[3]

Dependent Variable

For each type of aviation fuel, the dependent variable—or the variable to be explained in the model—is the average price of that fuel at an airport, net of state taxes.[4] If an airport has only one FBO selling a fuel, the average price of that fuel at that airport is simply the price charged by the FBO that sells it. At an airport where two or more FBOs compete to sell the same type of fuel, the average price of the fuel is calculated as a simple (unweighted) average across all of the FBOs that sell the fuel at the airport. For 100LL, about 87 percent of airports in the all-airports dataset are served by only one FBO, and for Jet A, the share is lower, at about 84 percent.[5] We obtained data on posted aviation fuel prices from a company that publishes such data online for two separate dates—a Wednesday in October of 2018 and a Wednesday in May of 2019.[6] All of the fuel price data we received had been updated within 30 days of these dates.[7]

[3] We examined the subset of airports with an air traffic control tower because these airports generally have more operations, and we found that they are also more likely to be served by more than one FBO. Thus, the "towered only" dataset provided a greater degree of variation in the on-airport competition variable.

[4] Because the purpose of this analysis is to focus on the cost, demand, and competitive factors that correlate with fuel prices, we calculated fuel prices without state taxes. For each price in our data, we used information on aviation fuel excise taxes and sales tax rates by state, along with the fuel price, to derive the net price per gallon.

[5] While we obtained data on per-gallon prices posted by FBOs for aviation fuel, we did not obtain information on the quantities of fuel sold. Therefore, for airports with more than one FBO, we were not able to take a weighted average of prices based on sales and instead calculated a simple average based on the number of FBOs selling the fuel. That is, if there were three FBOs selling a given fuel at an airport, we added together the three prices posted and divided the total by three to calculate the average price used in the model.

[6] In the data we obtained, posted prices for aviation fuel did not reflect discounts, if any, that may be provided to purchasers based on special contracts or buyers' club deals. Based on our audit work, such discounts are more common in the sale of Jet A fuel than they are for 100LL. Despite this limitation, we believe the data we obtained are sufficiently reliable for our purposes.

[7] All findings from the model presented in this appendix were based on the May 2019 data. We also ran the model for the October 2018 data and all results were reasonably consistent.

Independent Variables

Independent variables in our model included a variety of demand, cost, and competitive factors that we hypothesized may explain the variation in fuel prices across airports. In particular, these factors relate to characteristics of (1) airports, (2) the locations where an airport resides, (3) the FBOs operating at a given airport, and (4) the availability of competing FBOs.

Characteristics of airports. We expected certain characteristics of each airport to be related to the level of fuel prices.[8]

- *Airport size*. We measured airport size based on the number of total operations—takeoffs and landings—at the airport.[9] Greater activity at an airport reflects higher demand for services, which we expected to correlate with higher prices. Moreover, it is likely more costly to provide services at these busier airports. As such, based on both demand and cost factors, we expected larger airports to have higher fuel prices. We obtained data on airport operations from the Federal Aviation Administration (FAA).

  Length of the longest runway. Longer runways can accommodate larger and heavier aircraft, which may increase demand of such traffic. Because larger and heavier aircraft require more fuel, a longer runway may be indicative of greater demand for fuel at the airport. At the same time, longer runways are more costly to construct and maintain. Thus both demand and supply factors related to having a longer runway would suggest that fuel prices could be higher at such airports. We obtained information on runway length, which we measure in thousands of feet, from FAA.

Characteristics of locations. We also expected demographic and geographic characteristics of the location of each airport to be correlated with fuel prices.

- *Demographic characteristics of the population living in the area near an airport*.
  - Personal income per capita. Areas where per-capita incomes are higher could signal a greater demand for air travel and airport

[8] We did not control for airport ownership of FBOs because such data were not available.

[9] Specifically, the measure is annual operations, excluding military operations, in tens of thousands.

services.[10] At the same time, areas with higher per-capita incomes also suggest that costs for labor and other resources the FBO will need to procure will be higher. Thus, we hypothesize that airports located in counties with higher per-capita incomes will have higher fuel prices. We obtained data on personal income per capita by county from the Bureau of Economic Analysis, Department of Commerce.

  - Square of per-capita income. We also expected that, as income levels rise, the effect of even higher levels of income on fuel prices will attenuate. To account for the possibility of a nonlinear relationship between income and fuel prices, we included a variable equal to the square of personal income per capita.
  - Population. A larger population in the area surrounding an airport would likely indicate higher demand for airport services.[11] We obtained population data by county from the Bureau of Economic Analysis, Department of Commerce.

- *Distance from Source of 100LL aviation fuel production*. Following production, 100LL is typically shipped over longer distances by truck, rail, or barge, while Jet A tends to be transported over longer distances by pipeline. As such, long-haul transport is relatively more costly for 100LL. We found that there is no production of 100LL in East Coast states, while most other states in the contiguous United States have production sources for 100LL in closer proximity.[12] Therefore, we controlled for the greater cost of transporting 100LL to states along the East Coast with a dummy variable in the 100LL pricing model.[13] We obtained information on production sources for 100LL from the Energy Information Administration, Department of Energy.

[10] The variable is denominated in income in thousands of dollars.

[11] Population is measured in hundreds of thousands.

[12] East Coast states in our data included Connecticut, Delaware, Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, and West Virginia.

[13] Because Jet A is typically transported by pipeline, we did not control for location on the East Coast in our analysis of Jet A prices.

Characteristics of FBOs. We included two variables in the model that relate to the services provided by FBOs at the airport

- *Large-Chain FBOs*. Based on our audit work, we hypothesized that large-chain FBOs—those with operations at numerous airports—are more likely to focus their business model on meeting the demands of pilots looking for a suite of services and amenities. We thus expected that an airport served by a large-chain FBO may have higher average fuel prices due to the costs of providing such services. We used the data on aviation fuel prices to determine the number of operations run by each FBO. For purposes of the model, we defined an FBO as a large-chain if the owner had at least 25 FBO operations across airports reported in our dataset.
- *Availability of self-service fuel at airport*. We hypothesized that the price for full-service 100LL might be lower at an airport where a self-service 100LL is also offered for sale.[14] That is, the ready availability of a cheaper fueling option may influence the pricing of full-service 100LL. Therefore, we included a dummy variable in the 100LL pricing model if self-service 100LL was also available at the airport. In many cases, only one FBO is available at an airport and provides both self-service and full-service 100LL. The variable is derived from the data on aviation fuel prices.

Degree of competition among FBOs. Economic theory suggests that market prices for a product will be lower when more firms are selling a product, all else equal. We examined "on-airport" competition among FBOs for both fuels, and for 100LL, we also developed a variable to account for competition at nearby airports.

- *The number of on-airport FBOs selling a given fuel*. The most immediate and likely relevant competition among FBOs would occur at a given airport. To examine the correlation between on-airport competition and aviation fuel prices, we used two alternative measures: (1) the number of FBOs selling the fuel at each airport and (2) a dummy variable that equals 1 for airports where more than one FBO sells the fuel and 0 otherwise. These competition measures were derived from the data on aviation fuel prices.

[14] Self-service Jet A is not as widely available as self-service 100LL, particularly at towered airports. For this reason, we thought the availability of self-service Jet A would be less important in explaining variation in full-service Jet A prices, and we did not include it in our Jet A regression specifications.

- *Availability of alternative FBOs at airports in the vicinity*. Because stakeholders we interviewed said that pilots using 100LL may consider using nearby airports where that fuel is less expensive rather than their intended destination airport, we examined whether the availability of FBO services at nearby airports correlated with 100LL prices. Specifically, we counted the number of different FBOs selling 100LL at airports within a 30-mile radius of each airport where 100LL is sold.[15] We derived this measure of competition from nearby airports by combining geospatial data for each airport with information from our data on aviation fuel prices.

Base-Case and Alternative Model Results

As noted, we ran the fuel-pricing model for both 100LL and Jet A aviation fuels. Table 4 provides descriptive statistics for all of the variables included in the models. We report regression results for several specifications in tables 5–9. Specifically these tables provide the extent and direction (plus or minus) of the estimated correlation of each of the independent variables on aviation fuel prices.[16] We also indicate whether each estimated correlation is statistically different from zero.

The per-gallon price of aviation fuel (100LL and Jet A)—the dependent variable in our model—is measured in dollars and cents. Some of the independent variables are measured in levels—for example, annual airport operations are measured in tens of thousands, and the length of the longest runway in thousands of feet. For these variables, the regression model results indicate the estimated correlation of a one-unit increase in the level of the independent variable on the price of aviation fuel. For example, as shown in table 4, an increase in runway length of 1,000 feet is associated with an increase in the price of both 100LL and Jet A of about 8 cents, and this estimated correlation is statistically different from zero at the 1 percent level. The model also includes some "dummy" variables—variables that take a value of either 1 or 0, depending on whether a specific attribute does or does not apply. For a

[15] To count the number of different FBOs selling 100LL at airports within a 30-mile radius of each airport where 100LL is sold, we took into account operations by large-chains. In particular, if a large-chain FBO provided 100LL at a particular airport, we did not count operations by the same chain FBO at airports within 30 miles in our measure of nearby competition. Similarly, in the absence of operations by a particular large-chain FBO at a particular airport, we counted operations by that chain only once at nearby airports.

[16] Tables 5-9 report estimated coefficients from the regression analysis for each independent variable. If no estimated coefficient is reported, the independent variable was not included in the specification of the regression model.

dummy variable, the estimated correlation is interpreted as the effect of the attribute on the per-gallon fuel price. Based on the findings in table 5, being located on the East Coast is associated with an increase in the price per gallon of 100LL fuel of about 22 cents. This correlation was also found to be statistically different from zero. In another example, the model specification shown on table 5 uses a dummy variable to indicate the presence of competition at an airport—the variable equals 1 for airports that are served by more than one FBO and 0 for airports that are served by only one FBO. Results in table 5 indicate that the price per gallon of Jet A fuel is about 35 cents lower at airports that are served by more than one FBO than at airports with only one FBO.

Table 4: Descriptive Statistics for Variables Used in Analysis of Variation in Aviation Fuel Prices

Airports where 100 Low Lead (100LL) Is Sold				
	All-airports dataset (1,581 airports)		**Towered-airports dataset (528 airports)**	
Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Average net price (posted price excluding excise and sales taxes) (dollars per gallon)	5.10	0.74	5.67	0.77
Annual airport operations (excludes military operations) (tens of thousands)	4.90	7.22	9.66	10.56
Length of longest runway (thousands of feet)	6.21	2.12	7.93	2.34
Air traffic control tower is present at the airport (1=yes, 0=no)	0.33	0.47	1.00	0
Personal income per capita in county (thousands of dollars)	45.68	13.13	50.40	16.35
Square of personal income per capita in county	2,258.70	1,988.41	2,806.93	2,964.50
Population in county (hundreds of thousands)	4.14	10.74	8.97	16.02
East Coast location (1=yes, 0=no)	0.29	0.45	0.33	0.47
Self-service 100LL is sold at the airport (1=yes, 0=no)	0.49	0.50	0.39	0.49
Full-service 100LL is sold by at least one FBO operated by a large-chain (1=yes, 0=no)	0.11	0.31	0.30	0.46
Number of airports within 30 miles where full-service 100LL is sold	2.23	2.15	3.01	2.53
Number of FBOs selling full-service 100LL at airports within 30 miles	2.73	3.01	3.90	3.77
Number of FBOs selling full-service 100LL at the airport	1.17	0.50	1.45	0.75
On-airport competition indicator (1=yes, 0=no)	0.13	0.33	0.32	0.47

	Airports where full-service Jet A is sold			
	All-airports dataset (956 airports)		Towered-airports dataset (422 airports)	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
Average net price (posted price excluding excise and sales taxes) (dollars per gallon)	4.89	1.01	5.43	1.04
Annual airport operations (excludes military operations) (tens of thousands)	6.38	8.91	10.81	11.73
Length of longest runway (thousands of feet)	6.59	2.32	8.10	2.40
Air traffic control tower is present at the airport (1=yes, 0=no)	0.44	0.50	1.00	0
Personal income per capita in county (thousands of dollars)	47.80	15.69	51.71	16.95
Square of personal income per capita in county	2,530.65	2,709.38	2,960.34	3,197.34
Population in county (hundreds of thousands)	5.81	12.77	10.30	17.35
Full-service Jet A is sold by at least one FBO operated by a large-chain (1=yes, 0=no)	0.17	0.38	0.37	0.48
Number of FBOs selling full-service Jet A at the airport	1.22	0.56	1.46	0.75
On-airport competition indicator (1=yes, 0=no)	0.16	0.37	0.34	0.47

Source: GAO analysis of fixed base operator (FBO) fuel price data. | GAO-20-16

Table 5: Fuel-Pricing Regression with On-Airport Dummy Variable (All-Airports Dataset)

Variable	Price of full-service 100 low lead (100LL)	Price of full-service Jet A
Intercept	3.66[c]	3.47[c]
Airport operations	0.023[c]	0.019[c]
Longest runway	0.081[c]	0.077[c]
East Coast States = 1	0.22[c]	
Per-capita income in county	0.019[c]	0.012[c]
Square of per-capita income in county	-0.000060[c]	0.000030
Population in county	0.0059[c]	-0.00077
Large-chain FBO operates at airport = 1	0.61[c]	1.24[c]
Self-service 100LL available at airport	-0.105[c]	
At airport more than one FBO = 1	0.036	-0.35[c]
Observations	1,581	956
R-square	.52	.50

Source: GAO analysis of fixed base operator (FBO) fuel price data. | GAO-20-16

[a] indicates coefficient is statistically different from zero at the 10-percent level, [b] indicates coefficient is statistically different from zero at the 5-percent level and [c] indicates coefficient is statistically different from zero at the 1-percent level.

Table 6: Fuel-Pricing Regression with On-Airport Competition as the Number of FBOs (All-Airports Dataset)

Variable	Price of full-service 100 low lead (100LL)	Price of full-service Jet A
Intercept	3.66[c]	3.75[c]
Airport operations	0.023[c]	0.020[c]
Longest runway	0.081[c]	0.074[c]
East Coast States = 1	0.22[c]	
Per-capita income in county	0.019[c]	0.012[b]
Square of per-capita income in county	-0.000061[c]	0.000030
Population in county	0.0061[c]	-0.00066
Large-chain FBO operates at airport = 1	0.62[c]	1.26[c]
Self-service 100LL available at airport	-0.105[c]	
Number of FBOs selling type of fuel at airport	0.0041	-0.27[c]
Observations	1,581	956
R-square	.52	.51

Source: GAO analysis of fixed base operator (FBO) fuel price data. | GAO-20-16

[a] indicates coefficient is statistically different from zero at the 10-percent level, [b] indicates coefficient is statistically different from zero at the 5-percent level and [c] indicates coefficient is statistically different from zero at the 1-percent level.

Table 7: 100 Low Lead (100LL) Pricing Regression Considering Both Nearby and On-Airport Competition (All-Airports Dataset)

Variable	Price of full-service 100LL
Intercept	3.66[c]
Airport operations	0.023[c]
Longest runway	0.081[c]
East Coast States = 1	0.22[c]
Per-capita income in county	0.019[c]
Per-capita income in county squared	-0.000060[c]
Population in county	0.0060[c]
Large-chain FBO operates at airport = 1	0.61[c]
Self-service 100LL available at airport	-0.105[c]
At airport more than one FBO = 1	0.036
Number of FBOs operating at nearby airports	-0.00051

Variable	Price of full-service 100LL
Observations	1,581
R-square	.52

Source: GAO analysis of fixed base operator (FBO) fuel price data. | GAO-20-16

[a] indicates coefficient is statistically different from zero at the 10-percent level, [b] indicates coefficient is statistically different from zero at the 5-percent level and [c] indicates coefficient is statistically different from zero at the 1-percent level.

Table 8: Fuel Pricing Regression with On-Airport Competition Dummy Variable (Towered-Airports Dataset)

Variable	Price of full-service 100 low lead (100LL)	Price of full-service Jet A
Intercept	4.63[c]	4.64[c]
Airport operations	0.022[c]	0.022[c]
Longest runway	0.028[b]	0.017
East Coast States = 1	0.25[c]	
Per-capita income in county	0.0084[b]	0.00074
Per-capita income in county squared	-0.000021	0.000047
Population in county	0.0041[b]	-0.0041[a]
Large-chain FBO operates at airport = 1	0.67[c]	1.21[c]
Self-service 100LL available at airport	-0.107[b]	
At airport more than one FBO = 1	-0.111[b]	-0.487[c]
Observations	528	422
R-square	.49	.46

Source: GAO analysis of fixed base operator (FBO) fuel price data. | GAO-20-16

[a] indicates coefficient is statistically different from zero at the 10-percent level, [b] indicates coefficient is statistically different from zero at the 5-percent level and [c] indicates coefficient is statistically different from zero at the 1-percent level.

Table 9: 100 Low Lead (100LL) Pricing Regression Considering Both Nearby and On-Airport Competition (Towered-Airports Dataset)

Variable	Price of full-service 100LL
Intercept	4.63[c]
Airport operations	0.022[c]
Longest runway	0.028[b]
East Coast States = 1	0.25[c]
Per-capita income in county	0.0083[a]
Per-capita income in county squared	-0.000021
Population in county	0.0040[b]
Large-chain FBO operates at airport = 1	0.67[c]
Self-service 100LL available at airport	-0.107[b]
At airport more than one FBO = 1	-0.112[b]
Competition from nearby airports	0.00065
Observations	528
R-square	.49

Source: GAO analysis of fixed base operator (FBO) fuel price data. | GAO-20-16

[a] indicates coefficient is statistically different from zero at the 10-percent level, [b] indicates coefficient is statistically different from zero at the 5-percent level and [c] indicates coefficient is statistically different from zero at the 1-percent level.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Andrew Von Ah, (202) 512-2834 or VonahA@gao.gov

Staff Acknowledgments:

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