state or municipal governments, and the federal role is limited to providing grants-in-aid.

Federal actions can affect efficiency at airports, however. Terminal congestion can be reduced by expanding capacity and using existing capacity more efficiently. In addition, air traffic control (ATC) services are linked with runway capacity, so if that capacity is inadequate, ATC will also be constrained. It is more likely, however, that the greatest payoff from federal activity lies with efforts to improve air traffic control technologically and to find appropriate prices for ATC services.

## The Users of the Air Traffic Control System

For purposes of this study, the direct users of the air traffic control system are the operators of commercial and private aircraft, not the passengers or freight carried by the aircraft. The aircraft is the element whose safe movement is of concern to air traffic controllers, regardless of who or what is on board. A study of airport costs would have to consider passengers (as well as pilots and other employees) as users, since they impose demands directly on airport facilities that entail costs to the airports.

## The Services that the Federal Government Provides to Aviation

The major components of FAA spending include operations and capital improvements (see Table 7). About 55 percent of the FAA's outlays in 1991 were spent on operations. The largest component of that spending was for the air traffic control system. The FAA's capital spending is divided almost evenly between the Airport Improvement Program, which provides grants to airports, and facilities and equipment (F&E) used to keep track of aircraft and guide them safely to their destinations. A small amount of capital spending goes for research, engineering, and development (RE&D) to find ways of improving the FAA's air traffic control services.

The FAA's outlays for air traffic control services include all expenditures for F&E and RE&D plus spending on five categories of operations that seem most directly related to operating the air traffic control system: operation of the traffic control system, National Airspace System logistics support, design and management, maintenance of traffic control, and leased telecommunications services. The federal budget does not show outlays for these individual components of ATC. It does, however, show obligations, and since outlays track obligations over time, they can be used to

**Table 7.**
**Federal Aviation Administration and Air Traffic Control Spending, Fiscal Year 1991 (In millions of dollars)**

| | Amount | Percentage of Total |
|---|---|---|
| Capital Account | | |
| Airport Improvement Program | 1,541 | 21 |
| Air traffic control | | |
| Facilities and equipment | 1,512 | 21 |
| Research, engineering and development | 179 | 2 |
| Subtotal | 3,232 | 45 |
| Operations Account | | |
| Air traffic control share of operations[a] | 3,063 | 42 |
| Non-air traffic control share of operations[a] | 950 | 13 |
| Subtotal | 4,013 | 55 |
| Total | 7,241[b] | 100 |
| **Memorandum:** | | |
| Spending on Air Traffic Control | 4,754 | 66[c] |

SOURCES: *Budget of the United States Government, Fiscal Year 1993*, Appendix One, p. 746 and Table 12, p. 128.

a. Estimate from Table 12 on p. 128.

b. Includes a credit of $3 million for the Aviation Insurance Revolving Fund.

c. Percentages may not add up to subaccount totals because of rounding.

show the composition of spending on air traffic control. The estimated amount spent by the FAA on air traffic control in 1991 is shown in Table 7.

Some observers argue that aviation system users should cover the entire costs of the FAA. But the costs that are relevant to this study are those that relate directly to air traffic control. Therefore, federal grants to airports, administration of safety regulations, and headquarters services are excluded for the purposes of this analysis.

The services provided by the FAA for a typical flight begin well before takeoff and continue until the pilot has turned off the "fasten seat belts" sign at the airport gate. Air traffic controllers and other skilled personnel perform these services at a variety of facilities including:

- o Flight service stations;
- o Airport traffic control towers;
- o Terminal radar approach control facilities; and
- o Air route traffic control centers.

**Flight Service Stations (FSS).** FAA personnel at flight service stations help pilots plan their flights. They provide weather predictions, maps, and other information that helps pilots select the best routes and altitudes for their particular aircraft. The flight service stations are especially useful for general aviation--corporate jets and pleasure aircraft--which relies heavily on the FAA. Large commercial air carriers typically have their own sources of information and use their own computer models to determine the best flight paths. Airlines file flight plans electronically with air route traffic control centers. Therefore they do not use many FSS services.

**Airport Traffic Control Towers.** Airport tower traffic controllers are responsible for the safe movement of aircraft on the ground and in the air within a few miles of an airport. They direct departing aircraft from gates, along taxiways, to runways, and give permission for takeoff. After an aircraft is airborne, the tower controller relinquishes control to another controller who then tracks it by radar in the terminal radar approach control facility (TRACON). For incoming aircraft, the process is reversed; the tower controller directs the aircraft from the time it is relinquished by the TRACON controller until it is parked at the arrival gate.

Tower controllers observe the movements of aircraft from glassed-in enclosures high enough for them to see the airport's runways and taxiways. Thus, they can track aircraft both in the air and on the ground.

The FAA is buying new equipment to monitor aircraft on the ground more effectively and to provide warnings of potential collisions. For instance, better equipment might have prevented recent accidents in Los Angeles, where a commercial jet and a small commuter aircraft collided on a runway, and in Detroit, where a pilot lost in fog taxied onto a runway from which another jet was taking off.

In 1989, the FAA operated control towers at about 400 airports, including all major commercial terminals. Many small airports used primarily by general aviation do not have towers.

**Terminal Radar Approach Control Facilities.** Once an aircraft is airborne, the tower controller hands it over to the controller in the TRACON, who monitors it on radar, guides it some 30 to 50 miles out from the airport, and then relinquishes responsibility to a controller at an air route traffic control center (ARTCC). For incoming flights, the TRACON controller receives control of an aircraft from an ARTCC controller and guides it until it is close enough for the tower to take over.

At hub airports, many aircraft arrive at about the same time from one direction, and after an interval for unloading and loading passengers, depart en masse on continuing flights. For example, a number of flights from the East Coast may arrive at a hub within minutes of each other, give passengers three-quarters of an hour to catch connecting flights, and take off for the West Coast. At such times, TRACON controllers face tremendous pressures in lining up the aircraft on approach paths and keeping them safely separated. In areas with several fields, one TRACON is usually responsible for aircraft approaching and leaving all the airports. For instance, the TRACON at Chicago's O'Hare International Airport is also responsible for traffic at Midway, Meigs, and several other smaller airports in the region.

There are 188 TRACONS in the continental United States, all of which employ highly sophisticated tracking and communications gear. The FAA is trying to upgrade the facilities and equipment at all TRACONS as part of its long-term capital investment plan.

**Air Route Traffic Control Centers.** Controllers at ARTCCs monitor and guide aircraft until they near their destination and are handed to the local TRACON. The FAA operates 22 ARTCCs throughout the country, and together they cover virtually all of the nation's airspace.[6]

An aircraft may be handled by more than one ARTCC in the course of its flight.[7] A flight from Washington to Chicago, for example, is passed from the local TRACON to the Washington ARTCC at Leesburg, Virginia. From there it is passed along to controllers in the Cleveland, Indianapolis, and Aurora, Illinois, ARTCCs before being directed by the TRACON at O'Hare.

Commercial carriers constituted about half the operations handled by ARTCCs in 1988. The balance were general aviation, commuters, and government (mainly military). General aviation pilots may elect not to use the services of ARTCCs when flying in good weather under visual flight rules.

As sophisticated as ARTCC radar and communications equipment is, it is still inadequate under certain conditions. When the system begins to get overloaded, traffic controllers must juggle demands, directing aircraft to change altitude or course, or asking neighboring ARTCCs or TRACONs not to send any more aircraft to their sector until congestion eases. With better equipment, provided under the FAA's capital investment plan, the ARTCCs can handle more operations without sacrificing safety. At some facilities the newer equipment will require fewer controllers, thereby lowering operating costs as well. (See Table 8 for the traffic associated with each type of facility organized by class of user.)

In addition to airport towers, TRACONs, and air route centers, the FAA operates a central flow control facility that monitors aviation activity nationwide. Its purpose is to smooth the flow of traffic from sector to sector across the country. If, for instance, late-afternoon thunderstorms in New York City bring operations to a standstill even for a short period, waiting aircraft queue up in the air and on the ground. In order to minimize the number of circling airplanes, the FAA's flow control facility issues instructions to keep on the ground those bound for New York until they can be safely accommodated at their destination.

The Federal Aviation Administration's capital investment plan was launched in 1981 as the National Airspace System Plan to modernize the FAA's equipment and facilities. As it replaces outmoded and overloaded computers and communication equipment, the FAA will be able to manage many more operations than it can now. But the program has encountered numerous technical difficulties and

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6. Some airspace used for testing aircraft or conducting training missions is under military control.

7. As used by air traffic controllers, a "handle" consists of an instrument flight rules entry and departure from a sector and the guiding of an aircraft over the sector controlled.

**Table 8.**
**Operations Conducted by the Federal Aviation Administration in 1990, by Facility and Class of User (In millions of operations)**

| | Operations by User Class | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Commercial Carriers | | Commuters and Taxis | | General Aviation[a] | | Public Sector | | Total | |
| Facility | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Operations | Percent |
| ARTCC | 18.5 | 49 | 5.6 | 15 | 7.9 | 21 | 5.5 | 15 | 37.5 | 100 |
| ATCT[b] | 12.9 | 20 | 8.8 | 14 | 39.0 | 21 | 2.8 | 4 | 63.5 | 100 |
| FSS[c] | | | | | | | | | | |
| Pilot briefs | n.a. | n.a. | n.a. | n.a. | 11.5 | 47 | n.a. | n.a. | n.a. | n.a. |
| Instrument flight plans | n.a. | n.a. | n.a. | n.a. | 5.3 | 22 | n.a. | n.a. | n.a. | n.a. |
| Visual flight plans | n.a. | n.a. | n.a. | n.a. | 1.6 | 7 | n.a. | n.a. | n.a. | n.a. |
| Air contacts[d] | n.a. | n.a. | n.a. | n.a. | 6.1 | 25 | n.a. | n.a. | n.a. | n.a. |
| Total | n.a. | n.a. | n.a. | n.a. | 24.5 | 100[e] | n.a. | n.a. | n.a. | n.a. |

SOURCE: *FAA Aviation Forecasts, Fiscal Year 1992-2003*, (February 1992) Chapter X, Tables 27, 32, 34, and 35.

NOTES: ARTCC = air route traffic control centers; ATCT = air traffic control towers; FSS = flight service stations; n.a. = not applicable.

a. Data on flight service stations, pilot briefs, instrument flight plans, visual flight plans, and air contacts apply only to general aviation.

b. The FAA has consolidated the information from air traffic control towers and terminal radar approach control facilities in recent years.

c. These services are used predominantly by general aviation. No breakdown by user class is given.

d. An air contact is a radio communication between an aircraft and a controller at the flight service station.

e. Total may not equal 100 because numbers are rounded.

is well behind its original schedule.[8] Although originally expected to cost $12 billion, the cost of the plan is now estimated at $27 billion.[9]

While the CIP is being carried out, charging users according to the costs they impose on the traffic control system could serve two purposes: it could help alleviate congestion and could suggest which elements of the plan would yield the greatest benefits and should be given top priority.

8. The General Accounting Office has published a series of reports on the NAS Plan, including *Air Traffic Control: Challenges Facing FAA's Modernization Program*, GAO/T-RCED-92-34 (March 1992); *Air Traffic Control: Status of FAA's Effort to Modernize the System*, GAO/RCED-90-146FS, (April 1990); *Issues Related to FAA's Modernization of the Air Traffic Control System*, GAO/T-RCED-90-32, (February 1990); and *Continued Improvements Needed in FAA's Management of the NAS Plan*, GAO/RCED-89-7 (November 1988).

9. Committee for the Study of Air Passenger Service, *The Winds of Change*, p. 297.

# Current Financing Policy

The FAA gets its money from two sources: the general fund of the U.S Treasury and a set of aviation excise taxes. Almost all of the revenues from the aviation excise taxes are deposited in the Airport and Airway Trust Fund (AATF), from which the FAA makes all capital and some operations expenditures.[10] The AATF serves as a dedicated source of funding for the aviation system and facilitates comparing the amount of tax revenues collected from aviation sources and the amount of federal spending on aviation activities.

When the trust fund was established in 1970, it was intended to finance investments in aviation and, if funds were available, to help finance operations. Early attempts by the Nixon Administration to restrict capital spending while using the trust fund to finance operations led the Congress to impose limits on the amount of spending on operations that can be financed by the trust fund.[11] This study is concerned with both capital and operations spending for air traffic control; however, it does not consider the current legislative and institutional constraints on sources of financing for the different activities.

## The Tax on Passenger Tickets

The federal government taxes passenger tickets at 10 percent of the ticket value for domestic flights on commercial airlines.[12] In 1991, revenues from the ticket tax were $4.3 billion and accounted for 88 percent of total revenues from aviation taxes (see Table 9).

Although the tax on passenger tickets raises substantial amounts of revenue, it does not effectively promote efficiency. To begin with, it does not correspond closely to the FAA's cost of handling a passenger aircraft through the air traffic control system. The cost to the FAA is linked to the movement of the airplane, not the passenger. To air traffic controllers, it does not matter whether an airplane is empty or full; they handle it the same way and it imposes the same costs on the system. With the wide variety of discount fares available to passengers, moreover, ticket prices--and the resulting taxes--paid by different passengers on the same airplane may vary widely.[13]

**Table 9.**
**Aviation Excise Taxes, 1991**
**(In millions of dollars)**

| | Amount | Percentage of Total |
|---|---|---|
| Passenger Ticket Tax[a] | 4,341 | 88 |
| Freight and Waybill Tax[b] | 222 | 5 |
| Fuel Tax[c] | 140 | 3 |
| International Departure Tax[d] | 217 | 5 |
| Refund of Taxes | -10 | e |
| Total | 4,910 | 100[f] |

SOURCE: *Budget of the United States Government, Fiscal Year 1993,* Appendix One, p. 749.

a. Tax rate of 8 percent in 1990 on the value of domestic passenger tickets. The rate changed to 10 percent on December 1, 1990.

b. Tax rate of 5 percent in 1990 on the value of air cargo shipments. The rate changed to 6.25 percent on December 1, 1990.

c. Twelve cents per gallon of aviation fuel and 14 cents per gallon of jet fuel used by general aviation in 1990. The fuel charges changed to 15 cents and 17.5 cents per gallon on December 1, 1990.

d. Six dollars per person on international flights effective January 1, 1990.

e. Tax refunds were less than one percent of taxes collected.

f. Percentages do not add up to 100 because numbers are rounded.

10. The revenues from the increase in taxes on aviation fuels enacted in the Omnibus Budget Reconciliation Act of 1990 for the period December 1, 1990, through December 31, 1992 remain in the general fund. Thereafter, these revenues are dedicated to the Airport and Airway Trust Fund.

11. The AATF is described in detail in a Congressional Budget Office special study, "The Status of the Airport and Airway Trust Fund" (December 1988), and a CBO Staff Memorandum, "The Effects of Alternative Assumptions about Spending and Revenues of the Airport and Airway Trust Fund" (July 1990).

12. Title 26, U.S. Code, Section 4261(a). The rate increased from 8 percent to 10 percent on December 1, 1990, under provisions of the Omnibus Budget Reconciliation Act of 1990.

13. In April 1992, airlines began experimenting with simplified fare structures. The smaller variation in ticket prices implies passenger ticket taxes for the same flight will not vary so widely in the future.

A commercial airliner departing from Washington National Airport imposes the same demands on airport tower and TRACON personnel regardless of whether it is carrying business passengers paying full fare and bound for New York, vacationers paying discount fares and bound for Florida, or a mix of passengers bound for Dallas. But the total fares and taxes paid may vary greatly among those flights. For these reasons, the passenger ticket tax is not likely to serve as a good index to the FAA's cost.

*It would be only coincidental if the aviation excise taxes equaled marginal costs.*

There are, however, some factors that affect air traffic control costs, ticket prices, and ticket taxes in the same way. Ticket prices are usually higher for long flights than for short ones; correspondingly, air traffic control costs are higher for flights that pass through many sectors of airspace and make intermediate stops that require extra handling by controllers. Airplanes that operate when the air traffic control system is busiest and congestion costs are highest are likely to be filled with business travelers paying full fares--and correspondingly high taxes. These effects are coincidental, however; they do not reflect an intentional effort to tie passenger taxes to costs imposed on the aviation system.

## International Departure Tax

The federal government levies an international departure tax of $6 a passenger on every international flight originating in the United States. The tax applies to commercial flights on both domestic and foreign carriers.[14] Revenues in 1991 were $217 million, about 4 percent of revenues from aviation-related taxes. Because the international departure tax, like the passenger ticket tax, is imposed on passengers rather than on aircraft, there is no reason to expect that it would closely reflect the FAA's costs for handling international flights. The cost to the FAA of handling a large jet is the same regardless of whether it is carrying 300 passengers, paying a total of $1,800 in departure taxes, or just 150 passengers, paying a total of $900 in taxes. In addition, the tax does not reflect congestion costs.

## Freight Waybill Tax

Freight transported within the United States by commercial air carriers is subject to a tax of 6.25 percent of the waybill.[15] Revenues were $222 million in 1991, about 5 percent of total revenues from aviation excise taxes. The waybill tax does not necessarily correspond to the services provided by the air traffic control system, but it comes closer than the taxes on passengers. Air freight rates typically depend on the size, weight, distance traveled, and time sensitivity of the shipment. Some freight is carried in the cargo holds of passenger aircraft, while other freight moves on dedicated planes. Often the dedicated aircraft, such as those of Federal Express or United Parcel Service, operate at night. This pattern eases the demands imposed on the air traffic control system by peak-hour passenger flights, but it may increase the number of controllers on duty at night.

## Aviation Fuel Tax

Fuel used by general aviation is subject to an excise tax of 15 cents a gallon for aviation gas-

14. Title 26, U.S. Code, Section 4261(c). The tax increased from $3 on January 1, 1990.

15. Title 26, U.S. Code, Section 4271. Until December 1, 1990, the rate was 5 percent.

oline and 17.5 cents a gallon for jet fuel.[16] Revenues from these taxes were $140 million in 1991, about 3 percent of total revenues from aviation excise taxes.

Of all the aviation excise taxes, fuel taxes are most likely to correlate closely with costs imposed on the airway system, since fuel use is linked with distance traveled. Still, a small airplane flying between two small airports serving only general aviation and lacking control facilities would place few demands on the system--the pilot might check the weather with the flight service station and file a flight plan--but the same airplane flying the same distance (and using the same amount of fuel) between congested airports would cost the system much more. The fuel taxes paid would be the same for both flights.

The relationship between fuel taxes and costs is even more important. Although fuel taxes may be more closely correlated with costs than other aviation excise taxes, taxes do not necessarily cover costs. Total revenues raised from passenger ticket taxes may come much closer to covering the ATC costs associated with commercial airline transportation than do fuel tax revenues to covering ATC costs associated with general aviation. As for marginal costs, it would be only coincidental if the aviation excise taxes equaled marginal costs--a condition for efficiency.

# The Relationship of Taxes to Costs of ATC

In 1991, aviation tax revenues were $4.9 billion, while spending to equip, operate, and maintain the air traffic control system was estimated to be $4.8 billion. The FAA's airport improvement program received $1.5 billion of aviation tax revenues. During the last five years, FAA outlays for the ATC system averaged $4.2 billion annually, while revenues from aviation excise taxes were $4 billion.

Cost allocation studies by the FAA estimate that the public sector is responsible for about 15 percent of FAA costs.[17] If aviation activity by the public sector is considered separately from that of private users, FAA costs to private users would be reduced by 15 percent. Assuming that private-sector users were responsible for 85 percent of estimated ATC costs (about $4.1 billion in 1991), aviation excise taxes would have been sufficient to cover ATC expenses. But it should be kept in mind that the excise taxes are used for other expenditures such as grants to airports. In 1991, private users imposed total costs of about $6.2 billion on the FAA. The result was a shortfall in cost recovery of about $1.3 billion.

## Taxes Paid and Costs Imposed, by User Class

Different classes of users are taxed in different ways and impose different costs on the air traffic control system. Some studies have been undertaken to determine the relative costs and tax revenues and to discover whether some users are subsidizing others. As with highways, two approaches have been taken. One is the top-down approach, which allocates all FAA costs--including those not directly associated with air traffic control--among the various classes of users. An alternative, bottom-up approach has been taken by Gellman Associates (Richard Golaszewski in particular), who estimated the marginal costs of individual operations by users from different

16. Title 26, U.S. Code, Section 4041(c). Until December 1, 1990, the rates were 12 cents a gallon for aviation gasoline and 14 cents a gallon for jet fuel. In 1991, $14 million of revenue from the fuel tax--the projected amount attributable to the tax increase--will remain in the general fund, as provided by the Omnibus Budget Reconciliation Act of 1990.

17. Daniel Taylor, *Airport and Airway Costs: Allocation and Recovery in the 1980s*, FAA-APO-87-7 (Washington, D.C.: National Technical Information Service, February 1987), p. 8.

**Table 10.**
**Marginal Costs of Air Traffic Control Services in 1985 (In 1985 dollars)**

| Facility Type | Activity Measure | Air Carrier | Commuter | General Aviation | Public Sector |
|---|---|---|---|---|---|
| Air Route Traffic Control Center | Total handles[a] | 13.93 | 13.93 | 12.63 | 21.30 |
| Terminal Radar Approach Control | Operation, seconds and over[b] | 12.80 | 12.80 | 3.44 | 12.80 |
| Air Traffic Control Tower | Operation[c] | 7.91 | 1.86 | 1.44 | 4.45 |
| Flight Service Station[d] | Pilot briefs | 6.86 | 6.86 | 6.86 | 6.86 |
| | IFRFP | 6.86 | 6.86 | 6.86 | 6.86 |
| | VFRFP | 13.68 | 13.68 | 13.68 | 13.68 |
| | Air contacts | 3.87 | 3.87 | 3.87 | 3.87 |

SOURCE: Richard Golaszewski, "The Unit Costs of FAA Air Traffic Control Services," *Journal of the Transportation Research Forum*, vol. 28 (Arlington, Va.: Transportation Research Forum, 1987), pp. 13-20.

NOTE: IFRFP = instrument flight rules flight plan; VFRFP = visual flight rules flight plan; air contacts = a radio contact between the pilot and the flight service station.

a. In a "handle," a controller receives an aircraft operating under instrument flight rules from a terminal radar approach control facility (TRACON). The controller then guides the aircraft through airspace that the air route traffic control center is monitoring, and hands it over to a TRACON.

b. A TRACON operation occurs when the plane lands at the primary airport associated with the TRACON. Seconds and overs refers to aircraft that have traveled to another airport and were handed over to another TRACON or airport control tower.

c. An air traffic control tower operation is defined as a landing or takeoff by an aircraft.

d. The costs of the various flight service station services were the same for all users.

classes.[18] The marginal cost approach is more relevant to this chapter, since the focus is on efficiency.

## Marginal Costs: The "Bottom-Up" Approach

Understanding the costs associated with use of the air traffic control system entails breaking down aircraft operations into the parts that use FAA services.

**Marginal Costs to the FAA.** It is difficult to determine the marginal costs of services provided by the air traffic control system. A typical flight makes use of a variety of services, each of which imposes a marginal cost on the FAA. The study by Richard Golaszewski estimated the marginal costs of various FAA services provided to different classes of users (see Table 10). In some cases, the estimates of marginal costs were identical for different classes of users, such as handlings by TRACONs of air carriers, commuters, and government flights, because the available data did not distinguish among them statistically. (See Box 3 for an explanation of how Golaszewski used econometrics to estimate the marginal costs.)

18. Richard Golaszewski, "The Unit Costs of FAA Air Traffic Control Services," *Journal of the Transportation Research Forum*, vol. 28 (Arlington, Va.: Transportation Research Forum, 1987), pp. 13-20.

Golaszewski's estimates do not distinguish between peak and offpeak marginal costs. The FAA is likely to incur greater costs at peak hours because more controllers are needed to direct additional traffic, but it is not clear whether peak traffic raises marginal costs to the FAA. It is clear, however, that in peak periods additional aircraft impose additional marginal costs in the form of delays on other users of the system.

**Box 3.**
**Using Econometrics to Measure Marginal Costs**

The relationship between costs and units of FAA service can be estimated by linear regression techniques.[1] One study by airline analyst Richard Golaszewski used sites as his reference points: an air route traffic control center, a terminal radar approach control center, an airport traffic control tower, or a flight service station. For each type of facility, he regressed the cost of operating the site against the numbers of operations of the different classes of users--air carriers, commuters, general aviation, and the public sector. The estimated coefficient for each class of users is the marginal cost of that class, and the constant term in each estimated equation represents the fixed cost--not specific to any individual class of users--of the facility. The marginal costs of facilities are estimated, although because of data limitations, capital costs (buildings and air traffic control equipment) are not represented in the marginal cost coefficients. Underlying the cross section statistical analysis is the assumption that each facility is the optimal size for the work it does.

Although Golaszewski's estimates of marginal costs are somewhat out of date--they are based on 1985 data--his work provides a methodology that can be used to calculate marginal costs and show roughly the size of marginal costs compared with total costs of the air traffic control system. Golaszewski estimates marginal costs to be between 20 percent and 40 percent of total costs; the other 60 percent to 80 percent of costs include joint costs at the various sites, equipment maintenance not allocated to the sites, general overhead, and capital spending on facilities and equipment and research and development.

1. Richard Golaszewski, "The Unit Costs of FAA Air Traffic Control Services," *Journal of the Transportation Research Forum*, vol. 28 (Arlington, Va.: Transportation Research Forum, 1987), pp. 13-20.

**Marginal Costs to Other Users.** When the aviation system is not congested, the marginal cost is the addition to the total cost to the FAA of handling one additional user. Alternatively, the marginal cost is the cost that could be avoided if the additional use was forgone. With congestion, however, the marginal cost includes additional costs of delays experienced by other users. When the airways system is congested, each additional user increases the time that others must wait before being served.

**Congestion Costs.** When the system is congested, the costs of delay may be large. At these times, only users who value the service very highly, such as aircraft carrying a couple of hundred business passengers, will be willing to pay the high social marginal cost. Users who place less value on flying into a congested airport at a busy time will be encouraged to make alternative arrangements. For example, general aviation users can shift to a less congested airport, and general aviation or commercial aircraft carrying a high proportion of vacation travelers whose time is more flexible than that of business travelers can choose other travel times. In that way, congestion at peak hours will be alleviated.

Congestion can also impose high costs on the airlines if delays are severe enough to interfere with their schedule of operations. Late arrivals into hub airports, for example, can produce a domino effect, spreading delays throughout the system.

Numerous studies have estimated the value that travelers place on their travel time--or, in other words, how much they would be willing to pay to get to their destinations more quickly. On the basis of these studies and its own research, the FAA estimates that the average value of time for business trips is $44.24 an hour. For nonbusiness trips, the estimated value is $38.03 an hour.[19]

19. These values are expressed in 1991 dollars and are derived from FAA's estimates of $37.06 for business and

(Continued)

Consider, for example, a flight departing from a busy airport during the late afternoon peak. Each aircraft added to the queue awaiting clearance for takeoff contributes to delays for aircraft behind it in line. If there are five aircraft in the queue, each carrying 100 passengers who value their time at $40 an hour, and if the average delay is 6 minutes (0.1 hour), the first aircraft imposes a delay cost of $1600 on the other four. Similarly, the second aircraft in the queue causes congestion costs of $1200, the third $800, and the fourth $400. If surcharges corresponding to these amounts were imposed for takeoffs at the peak hour, some aircraft--particularly those with fewer passengers or more vacationers with discounted fares--would probably shift their flights to less congested, less costly hours.

The delay time is the same regardless of the type of user; a corporate jet would impose the same delay cost on others as a larger airplane.[20] To promote efficiency, the congestion charge should be the same regardless of aircraft type or user class. At offpeak hours, when there are no queues, the delay cost and congestion charge would be zero.

Bad weather heightens delays. Maintaining an extra margin of safety when visibility is low requires keeping aircraft farther apart than in clear weather. This step reduces the number of aircraft that the air traffic control system can handle in a given period of time. Pricing for congestion would highlight the cost of delays at specific locations and would help locate places where improvements in the air traffic control system would reduce delays.

The FAA has estimated that congestion and delays add about $5 billion annually to the airline operations. It is unlikely that charging users for the congestion they cause would raise that much in revenues. The revenues that could be expected from congestion pricing are more likely to be between $1 billion and $2 billion.[21]

**Environmental Costs.** Pollution is another social cost that should be taken into account. Noise pollution is an important factor in an airport's decision to increase the number of runways and operations. Air pollution from jet fuel may need to be priced as traffic expands. At present, however, there is stronger agreement among analysts about the practicability of pricing for congestion than for other social costs.

To achieve efficient use of the system, users should be charged the sum of the marginal cost to the FAA and the marginal cost of delays and pollution. This total is called the marginal social cost.

## Comparison of Revenues Raised from Taxes and Marginal Costs for Selected Types of Flights

The FAA's Cost Allocation Study concluded that some classes of users pay more than their

19. Continued

$31.86 for nonbusiness trips (in 1987 dollars), using the consumer price index. The estimates from studies reviewed by the FAA ranged from $20 an hour for military business travelers to $140.47 an hour for general aviation travelers using turbine powered aircraft, and from $26.97 an hour (for domestic passengers on commercial air carriers) to $210.71 an hour (for general aviation travelers using turbine powered aircraft) for nonbusiness trips. The high-end estimates accounted for a very small percentage of all users. See Stefan Hoffer and others, *Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs*, FAA-APO-89-10 (Federal Aviation Administration, October 1989), p. 11.

20. There may be some differences in delay time for various types of aircraft because of the need to provide proper spacing between aircraft.

21. This range of revenues from pricing for congestion at crowded airports is based on some assumptions. The FAA found that in 1988, commercial airlines experienced delays of more than 20,000 hours at each of 21 airports. The passengers on these aircraft (about 100 passengers per aircraft) might have been willing to pay for reducing the amount of delay. Depending on how much congestion is deemed optimal, how much congestion is due to weather, and how much time is worth to passengers, the revenues from charging these passengers could vary from $1 billion to $2 billion. For the FAA estimates of the value of time to passengers, see footnote 19 in this chapter. In 1989, bad weather accounted for 57 percent of all delays.

share of costs and some pay less (see Box 4).[22] One can also ask whether individual aircraft are paying enough to cover the marginal costs they impose on the system. The most efficient use of the system occurs when the price is equal to the marginal cost.

There is, of course, no typical flight with which marginal costs and tax revenues may be compared, but a commercial airline flight from Washington, D.C., to Chicago will serve as an illustration. As it moves through various portions of air space, the flight imposes marginal costs on each ATC facility it traverses. Using Golaszewski's 1985 estimates, if those costs rose at the same rate as the gross national product (GNP) deflator, the cost would be about $135 in today's dollars. If the aircraft carried 100 passengers paying an average of $150 apiece, the passenger ticket tax (10 percent of the ticket price) would yield revenues of $1,500 for the trip.[23] If the flight were filled with full-fare business passengers, the tax revenues would be much higher; if it were carrying mostly tourists paying deep-discount fares, revenues would be lower.

If the aircraft carried freight instead of passengers, tax revenues would depend on the size of the waybill, which in turn would depend on such shipment characteristics as volume, weight, fragility, and priority.

A general aviation aircraft flying from Washington to Chicago would make somewhat different demands on the air traffic control system, depending on whether it went by instrument (IFR) or visual flight rules (VFR). If the aircraft followed IFR, the cost to the air traffic control system would be about $105. If it followed VFR rules, the cost would drop to $30. A small plane for transporting executives might use about 250 gallons of aviation fuel, paying a tax of 17.5 cents a gallon, thus yielding about $45 in total revenues.

22. Taylor, *Airport and Airway Costs*.

23. Most passenger carriers also carry freight, in addition to passengers' baggage. Revenues from the waybill tax should be included in total revenues.

It is therefore possible that a general aviation aircraft, not maintaining much contact with the ATC, may pay more in aviation excise taxes than its marginal cost. But if it operates under IFR, it could pay much less.

Although there is no average or typical experience, these examples help illustrate that the existing tax structure does not reflect marginal costs to the FAA. As a result, users of the system get no signals encouraging efficient use.

# Alternative Financing Mechanisms

As the preceding discussion suggests, the present system of aviation excise taxes does not provide strong incentives for efficient use of the airways. The taxes imposed on each user group do not reflect marginal costs, and total revenues from all aviation taxes are insufficient to cover the FAA's costs for air traffic control services. Moreover, cost allocation studies suggest that some classes of users pay more of their share of the costs than others. Are there alternative financing mechanisms that would provide incentives for efficient use of and investment in the airways?

## Marginal Cost Pricing

One option is to charge each user the marginal cost of using the airways. Charging users the social marginal cost provides incentives for efficient use of the system. Users who value the service enough to pay the costs associated with it will use it, while those who do not will find alternatives.

The marginal costs estimated by Golaszewski could serve as a starting point for setting efficient prices for users of the air traffic control system. Users could be charged a price equal to the marginal cost of each service they received. Charges could be based on the

## Box 4.
## The "Top-Down" Approach

### FAA Cost Allocation Study

The Federal Aviation Administration periodically conducts studies to allocate costs among users. (See the table at right for the findings of the FAA's most recent cost allocation study.)[1] The main user classes are air carriers, general aviation, and the public sector. The air carrier class as a whole did not pay all the costs for which it was responsible. Passengers on domestic airlines paid more in ticket taxes than the air traffic control costs caused by the planes carrying them. But the commuter subclass had a deficit per operation of $108.82, and the deficit per operation for international flights was $32.33.[2]

The general aviation deficits and deficits per operation are substantial. Turbine-engine aircraft generated the largest deficit per operation ($111). Piston-engine aircraft flew a large number of operations--more than three times the number of domestic commercial flights--thereby generating the largest overall deficit.

Since the revenues for the public sector come from the general fund, revenues from aviation charges cannot be compared with the costs generated by the public sector. An alternative approach assumes that taxpayers pay for two kinds of aviation costs: the cost of public sector aviation and the cost of making up the deficit of the other users. About $704 million is associated with public-sector users. The remaining $887 million (shown as the surplus of the public sector in the table) is a subsidy by the general taxpayer to the other users of aviation infrastructure.

To summarize, the FAA found that in 1985 taxes paid by all users of the aviation system did not cover the FAA's cost of providing aviation services. But tax revenues from domestic air carriers exceeded their FAA costs. Commuter carriers and all categories of general aviation contributed substantially less in tax revenues than their costs.

### Methodology of the Study

The FAA study analyzed all aviation system costs--including the airport grant program, regulatory activities, and administrative overhead--not just air traffic control, since the purpose was to determine how much users of the entire aviation system pay and how much the FAA spends on their behalf. The study is thus concerned more with equity than efficiency--whether users are paying their fair share of the costs they impose.

The FAA study's general approach was to determine which costs were attributable to each user group. If a given FAA activity was directly linked to just one user group, such as commercial passenger carriers, the study assigned all the costs of that activity to that user group. If an FAA activity was performed for all types of aviation, the study allocated the joint costs according to several criteria, including each group's use of the aviation system, the marginal costs associated with each group, and a markup based on the elasticity of each group's demand. Overhead and other indirect costs not associated directly with operations were assigned to users in much the same way as direct joint costs.

The FAA study used two methods of allocating joint costs--that is, those that cannot be directly attributed to any individual user group. The first--the "full-cost allocation method"--allocated joint costs among all the user groups. The second--the "minimum general aviation allocation method"--allocated joint costs only among commercial and government users. This method regarded general aviation (GA) as marginal users of a system that would be in place anyway to serve commercial aviation, and so it allocated to GA users only the costs directly attributable to them. The costs attributed to GA under the minimum GA allocation method correspond to the marginal costs of GA as a class.

The costs reported in the table reflect the full-cost allocation method. Even under the minimum general allocation method, however, none of the categories of general aviation was found to contribute more revenues than its costs. That is, even under this method, which minimizes the costs attributed to it, general aviation does not pay its way.

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1. Daniel Taylor, *Airport and Airway Costs: Allocation and Recovery in the 1980s*, FAA-APO-87-7 (Washington, D.C.: National Technical Information Service, February 1987).

2. When analyzing tax revenues, the FAA classifies air taxis as general aviation because they are subject to the fuel tax imposed on general aviation. Passengers who hire air taxis are not subject to the passenger ticket tax. When counting numbers of operations, however, the FAA includes air taxi operations with commuter air carriers.

**Allocating Aviation Infrastructure Costs to Users and Revenues Collected from Users, 1985**

| | Cost (Millions of dollars) | Revenues (Millions of dollars) | Deficit (Millions of dollars) | Number of Operations (Millions) | Cost per Operation | Tax per Operation | Surplus or Deficit per Operation |
|---|---|---|---|---|---|---|---|
| Air Carrier | | | | | | | |
| Domestic | 2,176.0 | 2,419.0 | 243.0 | 9.03 | 240.88 | 267.78 | 26.90 |
| International | 121.2 | 108.3 | -12.9 | 0.40 | 303.75 | 271.42 | -32.33 |
| Freight | 122.9 | 134.1 | 11.2 | 0.70 | 175.46 | 191.45 | 15.99 |
| Commuters | 713.0 | 89.8 | -623.2 | 5.73 | 124.50 | 15.68 | -108.82 |
| Total | 3,133.1 | 2,751.2 | -381.9 | 15.86 | 197.55 | 173.47 | -24.08 |
| General Aviation | | | | | | | |
| Air Taxi | 131.7 | 12.7 | -119.0 | 2.96 | 44.56 | 4.30 | -40.26 |
| Piston | 683.0 | 23.5 | -659.5 | 30.48 | 22.41 | 0.77 | -21.64 |
| Turbine | 520.2 | 60.9 | -459.3 | 4.14 | 125.70 | 14.72 | -110.98 |
| Rotor | 63.8 | 3.0 | -60.8 | 2.12 | 30.03 | 1.41 | -28.62 |
| Total | 1,398.7 | 100.1 | -1,298.6 | 39.70 | 35.23 | 2.52 | -32.71 |
| Commuter and Air Taxi | 844.7 | 102.5 | -742.2 | n.a. | n.a. | n.a. | n.a. |
| Air Carrier and Air Taxi | 3,264.8 | 2,763.9 | -500.9 | n.a. | n.a. | n.a. | n.a. |
| Public Sector | 703.8 | 1,591.0 | 887.2 | 3.09 | 228.01 | 228.01 | 287.42 |
| with No Subsidy | 703.8 | 703.8 | 0.0 | 3.09 | 227.77 | 0.0 | 0.0 |
| Total (Carriers plus general aviation plus public) | 5,235.6 | 4,442.3 | -793.3 | 58.65 | 89.27 | 75.75 | -13.53 |
| Without Subsidy | 5,235.6 | 3,555.1 | -1,680.5 | 58.65 | 89.27 | 60.62 | -28.65 |
| **Alternative Cost Allocation: Minimum General Aviation Allocation** | | | | | | | |
| General Aviation | | | | | | | |
| Air Taxi | 48.3 | 12.7 | -35.6 | 1.53 | 31.61 | n.a. | -23.30 |
| Piston | 323.6 | 23.5 | -300.1 | 30.62 | 10.57 | n.a. | -9.80 |
| Turbine | 186.1 | 60.9 | -125.2 | 4.10 | 45.34 | n.a. | -30.50 |
| Rotor | 21.8 | 3.0 | -18.8 | 2.21 | 9.86 | n.a. | -8.50 |
| Total | 579.8 | 100.1 | -479.7 | 39.64 | 14.62 | n.a. | -12.10 |

SOURCES: Congressional Budget Office calculations and Daniel Taylor, *Airport and Airway Costs: Allocation and Recovery in the 1980s*, FAA-AP087-7 (Washington, D.C.: National Technical Information Service, February 1987).

n.a. = not applicable.

operation of the aircraft and the expected use of the control facilities. But charging for each contact with the ATC may be costly to audit, and operators might skimp on such contacts, thus decreasing the safety of the airways.

## Examples of Attempts at Marginal Cost Pricing

Although the FAA could, in principle, impose charges for congestion as a way of allocating scarce capacity of the air traffic control system, in practice such charges have been attempted only by airport authorities in connection with landing fees. From the economic standpoint of allocating scarce resources efficiently, it does not appear to matter which unit--the airport or the FAA--imposes the congestion fee, although both would be concerned about who gets the revenue.

Two attempts to impose congestion charges have had very different receptions. In 1968, the Port Authority of New York and New Jersey (PANY) imposed surcharges for peak-hour use by small aircraft at Newark, Kennedy, and LaGuardia airports.

PANY raised the peak-period minimum takeoff or landing fees for aircraft with fewer than 25 seats from $5 to $25, while keeping the off-peak fee at $5. Larger aircraft did not have to pay the fee but continued to be assessed according to their weight. Peak hours were defined as 8 a.m. to 10 a.m. on Monday through Friday and 3 p.m. until 8 p.m. on all days of the week. The PANY case demonstrated that peak/off-peak pricing differences were administratively feasible.

As a result of the surcharges at the New York and Newark airports, general aviation activity decreased by 19 percent overall and 30 percent during peak hours. The percentage of aircraft operations delayed more than 30 minutes declined markedly.[24]

The Aircraft Owners and Pilots Association (AOPA) took legal action in 1969 to have the fees canceled. The core of AOPA's argument was that the fee was openly discriminatory and infringed on the equality of access to air facilities. AOPA argued that PANY could not distinguish among aircraft from the point of view of their right of access to these public airport runways for landing and taking off, and that even if PANY had such a power, the present fee system was discriminatory.

The United States District Court found in favor of the Port Authority, ruling that the defendants were justified in distinguishing different classes of aircraft, on the grounds of safety and efficient use of landing facilities.[25] The court further recognized that the fee was meant to induce aircraft operators to use other times of the day or other facilities.

The PANY experience contrasts with that of an attempt by the Massachusetts Port Authority (Massport), the agency in charge of Boston's Logan airport, to reduce congestion by increasing landing fees for smaller aircraft. In 1988, Massport proposed a new formula for calculating landing fees. The formula was intended to reduce use by general aviation aircraft that were contributing to congestion. The main difference between the PANY surcharge and Massport's fee was that Massport's applied during both peak and off-peak periods. The authority's old fee was based solely on landing weight--$1.31 per thousand pounds with a $25 minimum. The new formula consisted of a relatively high base charge for landing--$88--and a smaller charge based on weight--47 cents per thousand pounds. The new fees resulted in smaller aircraft paying more than before and larger aircraft paying less (see Table 11).

The state of Maine and several associations complained that the new fee structure discriminated against general aviation. The U.S. Department of Transportation filed a suit

24. Office of Technology Assessment, *Airport System Development* (August 1984), pp. 118 and 131-132.

25. *Aircraft Owners and Pilots Association v. Port Authority of New York and New Jersey*, 305 Federal Supplement 93, S.D.N.Y. (1969).

**Table 11.**
**Old and New Fees at Boston's Logan Airport for Selected Aircraft**

| Type of Aircraft | Weight (Pounds) | Old Fee (Dollars) | New Fee (Dollars) |
|---|---|---|---|
| Beechcraft Bonanza F33 A/C | 3,400 | 25.00 | 89.60 |
| Boeing 737-200 | 107,000 | 140.17 | 138.29 |
| McDonnell Douglas DC-10 | 421,000 | 551.51 | 285.87 |
| Heaviest Aircraft Paying Minimum Under the Old Fee | 19,000 | 25.00 | 96.93 |

SOURCE: *Investigation into Massport's Landing Fees, Opinion and Order.* Federal Aviation Administration Docket 13-88-2; and Federal Trade Commission, *Proposed Comment on Massport's Program for Airport Capacity Efficiency,* Memorandum (February 18, 1988).

against Massport charging that the new fee structure unduly discriminated against small aircraft. An administrative law judge found that the new fee structure was unreasonable and contrary to federal statute and ordered Massport to revert to its old fee schedule. The judge also commented that "it would have been more credible for Massport to have adopted the surcharge type fee that the Port Authority of New York has imposed for peak hour small aircraft usage at Newark, La-Guardia, and Kennedy airports . . ."[26]

## Revenues from Marginal-Cost Pricing

Since charging users their marginal costs is economically efficient, the next issue is how much revenue can be raised from marginal-cost pricing. In 1985, if users had been charged the marginal costs estimated by Golaszewski, revenues would have been about $1.1 billion.[27] The corresponding revenues in 1991 would have been about $1.4 billion.[28] The estimated revenues could be less if airlines raise ticket prices to pass on some of the marginal costs to consumers. This could reduce the demand for flights and hence the revenues.

How do these revenues compare with total spending on the air traffic control system? FAA spending on air traffic control services is broken down in Table 12 into operations, facilities and equipment, and research, engineering, and development; the table also shows the estimated revenues from marginal cost pricing and total outlays during 1985 and 1991.

Table 12 shows that marginal-cost pricing would have failed to recover costs of operations or total air traffic control costs in 1985 and 1991. The estimates of spending on ATC were derived from the amounts obligated, and spending for operations was based on assump-

26. *Investigation into Massport's Landing Fees, Opinion and Order,* FAA Docket 13-88-2 (1988), p. 9.

27. Golaszewski, *The Unit Costs of FAA Air Traffic Control Services,* Parts I-III.

28. This estimate was calculated by converting the 1985 marginal cost for each service to 1991 dollars using the GNP deflator. The costs were then multiplied by the number of operations, pilot briefs, air contacts, times the aircraft was handled, and so forth, for each user class at each type of facility in 1991. The estimate assumes that public-sector users are paying the marginal costs for their use of the air traffic control system. This assumption is valid here because the intent of this section is to compare total ATC expenditures with the possible revenues from marginal-cost pricing. The information on air traffic control activity for 1991 is contained in various tables in the *FAA Aviation Forecasts,* 1992-2003.

**Table 12.**
**A Comparison of Spending on Federal Aviation Administration Air Traffic Control with Revenues from Marginal-Cost Pricing (In millions of 1991 dollars)**

| Category | Amount 1985 | Amount 1991 |
|---|---|---|
| Total Federal Aviation Administration Outlays | 5,061 | 7,241 |
| FAA Spending for Air Traffic Control[a] | | |
| Operations | 2,671 | 3,063 |
| Facilities and equipment | 523 | 1,512 |
| Research, engineering, and equipment | 322 | 179 |
| Total | 3,516 | 4,754 |
| Estimated Revenues from Marginal-Cost Pricing, Excluding Congestion Pricing | 1,308 | 1,399 |
| Difference (Between FAA spending on air traffic control and revenues from marginal-cost pricing, excluding congestion revenues) | 2,208 | 3,355 |
| Estimated Revenues from Marginal-Cost Pricing, Including Congestion Pricing | n.a. | 2,900 |
| Difference (Between FAA spending on air traffic control and revenues from marginal-cost pricing, including congestion revenues) | n.a. | 1,854 |

SOURCES: Budgets of the United States Government, Fiscal Years 1987 and 1993; FAA Aviation Forecasts, February 1992; FAA cost allocation model; and CBO calculations.

NOTE: n.a. = not applicable.

a. Estimated spending on air traffic control operations, research engineering, and development and facilities and equipment. The calculations were based on FAA's cost allocation model and number of operations at FAA facilities in 1985 and 1991.

tions about which operational activities are most closely related to the ATC system.[29] The FAA budget does not explicitly separate spending for air traffic control from such other spending as programs for safety, activities at headquarters, and other aviation activities that do not impinge directly on air traffic control.

The difference between FAA spending on ATC and revenues from marginal-cost pricing, excluding congestion revenues, increased from $2.2 billion in 1985 to $3.4 billion in 1991. The rise is partly explained by the increase in capital spending by the FAA during this period. Since capital expenditures are not usually counted as part of marginal costs, revenues would not have increased correspondingly.

## Problems with Marginal-Cost Pricing

The advantages in efficiency of marginal cost pricing must be weighed against several drawbacks. First, estimating marginal costs is not easy. Although Golaszewski has shown one way to estimate marginal costs, he cautioned that he had to make certain assumptions about use of capacity and other specific characteristics of the various facilities be studied. He apparently was unable to obtain enough data to distinguish between peak and off-peak periods, to determine whether marginal costs to the FAA varied by time of day.

29. Obligations for ATC operations are fairly close to outlays. Obligations for facilities and equipment, which can be commitments to spend on capital for many years into the future, can differ greatly from outlays, which are monies paid out during the year to contractors, possibly for work obligated in the past.

It is likely, however, that congestion costs have a stable component that can be used to set fees that do not vary unpredictably. Users would benefit from stable fees when making their decisions about when to use the system.

A second problem is how to administer a system of marginal-cost charges. Although the FAA keeps detailed records of aircraft handled, a system of billing commercial air carriers and general aviation for their use of FAA services would have to be devised.[30]

Finally, the estimates made by Golaszewski and the FAA's cost allocation study suggest that if users were charged only the component of marginal costs incurred by the FAA, revenues would not cover the FAA's costs of operating the air traffic control system. With additional charges for congestion, revenues might be sufficient to cover total costs, but distributional problems might arise if excess revenues from congested locations were used to cover costs at those that were not congested. Thus, it could be argued that the commercial air carriers and their passengers, who would pay the lion's share of congestion charges, would be subsidizing owners of private aircraft.

Congestion charges could be levied on aircraft at airports. Using the average value of time for aviation users, and the FAA's estimates of delays at congested airports, the revenues from congestion fees would be around $1 billion to $2 billion, an amount that could increase estimated revenues from marginal-cost pricing to between $2.4 billion and $3.4 billion.[31]

This estimate is subject to several qualifications. If congestion is a local phenomenon--that is, a crowded airport at New York can coexist with an uncongested airport in Iowa--the fees would be collected only at congested airports.[32] In addition, if airlines are required to pay these charges, they will pass on some of the costs to consumers, reducing congestion, demand for flights, and, consequently, the revenues from congestion charges. Finally, if the FAA is successful in making needed improvements at airports, congestion at the major airports would decline, reducing the estimated revenues from congestion fees.

If the purpose of congestion fees is to reduce congestion to an acceptable level, revenues from pricing for congestion could be used to finance improvements in capacity at congested airports. It has been estimated that increases in IFR arrival capacity at the top 25 airports (by number of operations) will require about $825 million.[33] The expected revenues of $1 billion to $2 billion from congestion fees could be used to finance these improvements and air traffic control as well.

Whether marginal-cost pricing covers total costs does not matter for the efficient allocation of resources in the short run, but it has long-run implications for investment decisions. Revenues greater than cost add strength to arguments that more spending is warranted on air traffic control. The excess of revenues over costs is likely to be greatest where the most congestion delays are experienced--and thus where investments to reduce delays would be most valuable.

If marginal-cost pricing would never yield enough revenue to cover the total costs of some activities, additional investment may or may not be justified. Cost-benefit analysis might help guide the investment decision. The gen-

30. The countries in the European Community are trying to put in place a single air traffic control system. It appears that collecting user fees in this system is administratively feasible. See Gellman Research Associates, *Towards a Single System for Air Traffic Control in Europe* (Jenkintown, Pa.: Gellman Research Associates, September 1989).

31. Department of Transportation, *1990-91 Aviation System Capacity Plan*, Table 1-5, p. 1-16.

32. Delays at a hub airport can cause delays throughout the system.

33. Committee for the Study of Long-Term Airport Capacity Needs, *Aviation System Capacity*, Table 3-5. These projects should lead to about 230 additional hourly IFR arrivals at those airports.

eral rule is that if users would be willing to pay for the investment--whether or not they are actually charged to cover its total cost--the investment is worth undertaking.

## Charging to Recover Total Costs

Even if charging all users the marginal cost of air traffic control services does not yield enough revenue to cover costs, there are several ways to make up this shortfall:

- Ramsey pricing;
- A subsidy from the general fund;
- Raising existing aviation excise taxes; and
- Raising marginal costs proportionately to the percentage of total costs.

## Ramsey Pricing

Applying Ramsey pricing to air traffic control services entails lowering or raising charges according to the reactions of users to price changes. Classes of users who would cut back sharply on their consumption of ATC services in response to a price increase would be charged either the marginal cost or only a small markup over it. (If charged the marginal cost, they would not fly less; a small markup would cause them to cut back.) Price markups would be higher for those users who were less sensitive to price increases--those who would continue to fly nearly as much as before, even if prices rose considerably. The difference between the price they would pay and the marginal cost for each unit would help cover the overhead costs.

This approach has different distributional consequences from simply charging marginal costs because some users would face higher prices than others. Commercial airlines probably would be less responsive to price changes than general aviation.[34] If so, under Ramsey pricing they could be expected to pay more for ATC services than general aviation.

## Charging Marginal Cost and Making Up Revenue Shortfalls from the General Fund

Another way to cover the costs of air traffic control while maintaining the advantage of marginal-cost pricing is to draw on the general fund of the U.S. Treasury to make up any difference between total costs and revenues from marginal cost pricing. In 1991, as Table 12 shows, the estimated contribution from the general fund would have been about $3.4 billion. If congestion charges had also been levied, the subsidy would have been about $1.9 billion.

## Charging Marginal Cost and Making Up Revenue Shortfalls with Existing Aviation Excise Taxes

In 1991, marginal-cost pricing would have yielded revenues of about $1.4 billion. Aviation excise tax revenues were about $4.9 billion. Thus, a combination of revenues from marginal-cost prices and taxes would have more than covered the $4.8 billion spending on FAA air traffic control. Revenues would be even higher if congestion charges were included in marginal costs. The surplus would then have been available to cover some of the FAA programs outside of ATC, primarily the Airport Improvement Program, which required outlays of $1.5 billion.

34. In its cost allocation study, the FAA assumes that general aviation users are twice as sensitive to price changes as commercial airline users. See Department of Transportation, Federal Aviation Administration, Office of Aviation Policy and Plans, *Allocation of Federal Airport and Airway Costs for FY 1985* (December 1986), Appendix A, pp. 5-9.

These numbers assume that users of the air traffic control system would not have cut back on use after paying the user fees. If they did cut back significantly, both fees and expenses would be less than the amounts given above. This option also assumes that the various aviation groups would agree to pay both the taxes and user fees for ATC when they had been paying only taxes for such services.

## Increasing Current Taxes Proportionately to Cover All Costs

This option dispenses with the efficiency of marginal-cost pricing; its sole objective is cost recovery. What aviation tax rates in 1993 would cover estimated total FAA outlays (FAA spending on both ATC and airports) for the private sector? Assuming that public-sector users account for 15 percent of FAA costs, total FAA outlays on the private sector in 1993 are estimated to be $7.3 billion. The tax rates in 1993 and the rates needed to recover these outlays are shown in Table 13. It is assumed that the ratio of each tax collected to the total tax collected remains the same. For example, since the passenger ticket tax receipts are about 88 percent of total taxes collected in 1991, the new rate of 13 percent yields about the same percentage of FAA outlays on the private sector.

The advantage of financing all costs through aviation excise taxes is that subsidy of private-sector users by the general fund would be eliminated. In addition, the misleading surplus in the trust fund would no longer grow. This surplus makes it appear that total FAA outlays have been less than aviation excise tax revenues. In fact, operations costs have been partly subsidized by the general fund, and therefore such a conclusion is unwarranted.[35] Finally, the federal deficit would be reduced by the amount now coming from the general fund to finance the costs imposed by private users.

If one of the objectives of the government is to promote aviation, the main disadvantage of raising aviation excise taxes is that levels of use could decline. Also, the commercial air carriers may object to an increase in the tax on passenger tickets when they are already paying more than the costs they impose on the FAA.

It should be emphasized that this option is at variance with the other approaches that aim at efficient use of the aviation network. It is mentioned primarily as a logical addition to the option of raising aviation taxes to cover the revenue shortfall from marginal-cost pricing.

**Table 13.**
**Tax Rates Needed to Recover Estimated Federal Aviation Administration Outlays for Fiscal Year 1993[a]**

| | 1991 Rate | Rate Needed to Recover Outlays |
|---|---|---|
| Passenger Ticket Tax (Percentage) | 10 | 13 |
| Freight and Waybill Tax (Percentage) | 6.25 | 8.125 |
| Fuel Tax (Cents per gallon)[b] | 16.8 | 22 |
| International Departures Tax (Dollars) | 6 | 7.80 |

SOURCES: *Budget of the United States Government, Fiscal Year 1993*, and CBO calculations.

a. Assumes all rates are raised proportionally so that revenues collected from aviation taxes equal FAA outlays for the private sector, which are estimated to be $7.3 billion in fiscal year 1993.

b. The fuel tax in the table is a weighted average (weighted by amounts of aviation fuel and jet fuel consumed by general aviation) of the aviation fuel tax of 15 cents per gallon and the jet fuel tax of 17.5 cents per gallon.

35. For an analysis of the aviation trust fund, see Congressional Budget Office, *The Status of the Airport and Airway Trust Fund* (December 1988).

## Marking Up Marginal Costs Proportionately to the Percentage of Total Costs

Total costs of the ATC system may also be recovered by charging each group a multiple of its marginal costs. The value of the multiplier is determined by the ratio of marginal costs to total costs incurred by each group. For example, in 1985, the marginal costs incurred by air carriers were about 21 percent of their total costs.[36] Thus, under a cost recovery scheme in which marginal costs form the base, air carriers would be charged about five times the marginal cost for services offered at ATC facilities.

For example, an air carrier flight from Washington, D.C., to Chicago imposes marginal costs of about $135 on the air traffic control system. If all ATC costs (including capital equipment and overhead) were to be covered by raising this marginal cost in proportion to the costs caused by air carriers, the total cost of the Washington, D.C., to Chicago trip would rise to $985. This total cost is greater than the proportionate increase in marginal costs mentioned above because of the high capital costs attributed to an IFR departure; such costs were not included in the marginal cost of a "handle," which is defined as two IFR departures plus guidance by air route traffic control centers.

If costs are allocated by a proportionate increase in marginal costs as in the example above, air carriers may pay less on an average flight than the revenues currently being collected through the passenger ticket tax. However, commuter air carriers would probably raise prices to defray the new costs, thereby causing a decrease in demand for their services. General aviation users would also be adversely affected by this procedure since they would have to pay more on a typical flight than the fuel taxes they are currently paying.

36. Golaszewski, *The Unit Costs of FAA Air Traffic Control Services*, Table 2.

For example, a corporate jet now pays about $43 in fuel taxes for a flight from Washington, D.C., to Chicago. If all ATC costs were to be covered by raising the marginal cost in proportion to the costs generated by general aviation for an IFR flight, the fee would be about $445. If it flew under visual flight rules and avoided contact with ATC centers en route, the fee would drop to $140. (This example merely serves to illustrate the difference between user fees for IFR and VFR. For efficient operation, a jet would have to cruise above 25,000 feet; thus, in practice it would fly IFR.)

Since users would pay more than marginal costs under this mechanism, levels of use would be lower than the efficient levels associated with marginal-cost pricing. There is also no attempt to tailor prices to demand while recovering costs, as under Ramsey pricing. The advantage of this method is that once costs have been allocated to the different classes of users, it is easy to administer.

Average-cost pricing is similar to the above method with the additional advantage that it does not require a determination of marginal costs. Under average-cost pricing, total costs to a service used by each group in the previous year are divided by the number of operations associated with that group in that year to get the fee.

# Conclusion

Existing federal taxes on users of the air traffic control system and other parts of the aviation system do not promote the efficient use of aviation infrastructure. Charging users their marginal cost could improve efficiency. The data for determining such fees is readily available.

Aviation taxes also do not raise enough revenues to cover the total expenses of the FAA. If the aim is to recover all costs of air