CHAPTER III. COST EFFECTIVENESS OF THE FAA PLAN

In the coming years, the Congress will consider legislation to appropriate funds for the National Airspace System Plan. Failure to appropriate the necessary sums would allow a decline in system productivity, while implementing the FAA plan would involve massive capital outlays with unassured benefits. As a compromise, aspects of the plan could be delayed or implemented selectively. The first part of this chapter examines the rate of return to be expected from the FAA plan as it would compare to a continuation of the current system. Since the assumptions underlying the plan are inherently uncertain (see Chapter I), the second section explores what could happen if things did not go as expected, concluding with an assessment of the plan's risk of achieving an unsatisfactory rate of return. The final section outlines some alternative approaches the Congress could take to help minimize such risks. (Appendixes C, D, and E provide technical background to the methodology used in the chapter.)

RATE OF RETURN

On the basis of benefit and cost projections (compare Tables 1 and 2 in Chapter II), the annual rate of return to be expected from investment in the FAA plan over the next 20 years is 24.3 percent--a healthy return by any standard. Indeed, compared with the commonly used, if perhaps arbitrary, projected rate of return standard of 10 percent (after inflation) set by the Office of Management and Budget for federal investment, the FAA plan appears to represent very good value. 1/ Another useful guide to the economic merit of a capital project is the present value of the expected benefits, minus the present value of the costs. Using FAA assumptions and 10 percent as the discount rate to adjust future costs and benefits to their present-day values, the plan's benefits are estimated to exceed its costs by $9.1 billion, for a benefit-to-cost ratio of 2.3:1 (see table below).

The 24.3 percent rate of return noted above does not indicate how quickly the FAA plan would begin to pay off. A long waiting period would

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1. For a discussion of discount rates and rates of return, see Appendix D, which notes that, in applying the 10 percent rate to judge whether a project is worth undertaking, OMB is subjecting proposals to a test that is both quite rigid and valid by private-sector standards.

INVESTMENT VALUE OF THE FAA PLAN
UNDER FAA ASSUMPTIONS, 1982-2005

Return on Investment			Timing
Rate of Return (In percent)	Benefit-to Cost Ratio a/	Benefits Minus Costs a/	Return in the First Year After Completion (In percent)
24.3	2.3:1	$9.1 billion	14.9

a. Benefits and costs are discounted to 1982 values at the annual rate of 10 percent.

mean that the overall success of the plan would hinge on ever more distant forecasts, and such distant forecasts inevitably tend toward speculation. On the basis of the FAA estimates of costs and benefits, the plan would have paid for itself by the sixth year. The FAA's forecasting record in looking this far ahead has improved markedly in recent years (see Appendix C), suggesting that going ahead with the project now would avoid unnecessary speculative risk.

An index of whether a project is well-timed is the ratio of benefits in the first year after a project's completion--1990 in this case--to its total cost (including interest). A first-year benefit ratio below 10 percent (the OMB **passmark**) indicates that the government could find more productive investments in the near-term. Based on the FAA estimates of costs and benefits, the expected first-year benefit is 14.9 percent, indicating that the FAA plan may actually be overdue.

EFFECTS ON THE RATE OF RETURN OF ERRORS IN ASSUMPTIONS

The foregoing conclusions are, of course, only as valid as the assumptions and forecasts on which they are based, and these cannot be absolutely certain. Thus, a look at what could happen to the plan if events did not materialize as assumed can be useful. As stated in Chapter I, key uncertainties exist in six areas:

- System consolidation;
- Growth in air traffic;
- Capital costs;
- Technological change;
- Economic effectiveness of separable components; and
- Pricing policy.

<u>System Consolidation and Savings in Operating and Maintenance Costs</u>

Savings in operating costs depend critically on closure of hundreds of manned facilities, and ultimately on a 40 percent reduction in the air traffic control system's authorized personnel level of more than 37,000 employees. Such changes have encountered opposition in the past in the Congress and among aviation groups. Evidence of this includes:

- Resistance to closing air route traffic control centers. In the past, the House Appropriations Committee has refused to fund the consolidation program for en route centers without prior notification of the center or centers proposed for closure. The requirement appears to have resulted from concern in localities over possible reductions in local employment.

- Statutory restriction of flight service station closings. Current legislation stipulates that only five flight service stations may be closed in 1983. Some general aviation interests continue to favor such restrictions, fearing a reduction in flight services. The FAA plan, however, calls for the closing of 75 stations in 1984.

- Opposition to regional office cutbacks. The FAA's 1981 proposal to cut back its regional offices from eleven to six faced employee protest, state resistance, and Congressional opposition. As a result, the FAA modified its consolidation plan, reducing the number of proposed 1983 closings from five to two.

Even if such reluctance delayed the changes by as much as five years, the overall project would still be worthwhile--with a rate of return of 13.9 percent. The project would take longer to pay off, however, and the first-year benefit ratio would fall below 10 percent, indicating that the plan's implementation now would be premature (see Table 5). This would also necessitate relying on more distant, less reliable forecasts rather than on the FAA's more accurate shorter-term forecasts.

TABLE 5. EFFECTS OF ALTERNATIVE PRODUCTIVITY ASSUMPTIONS ON EVALUATION OF THE FAA PLAN, 1982-2005

	Return on Investment			Timing
Assumption	Rate of Return (In percents)	Benefit-to-Cost Ratio a/	Benefits Minus Costs (In billions of dollars) a/	Return in the First Year After Completion (In percents)
Under FAA Assumptions	24.3	2.3:1	9.1	14.9
Five-Year Delay in Operating Costs Savings	13.9	1.5:1	6.8	8.6
Operating Costs Savings Improved by 50 Percent Less Than FAA Assumes b/	9.1	0.9:1	-0.4	5.5

SOURCE: Congressional Budget Office and FAA data.

a. Benefits and costs are discounted to 1982 values at annual rate of 10 percent.

b. Includes federal investment costs and federal benefits in the form of savings in FAA operating costs. Excludes avionics costs to airlines and general aviation users, and corresponding user benefits.

If opposition to organizational changes obviated half the total projected savings in operating costs, then the FAA plan would not prove worthwhile. That is, the discounted federal investment costs would exceed the discounted savings in FAA operating and maintenance costs.

Growth in Air Traffic

Independent of traffic growth, modernization can yield sizable gains in efficiency. But if FAA's traffic forecasts should prove to be too high, overall benefits would be lower than anticipated. Past FAA forecasts of the long-range growth in air traffic have been too high (discussed below), and this has led some analysts to question whether the FAA plan is well founded. 2/ The CBO has evaluated the forecasts from two perspectives: FAA's past forecasting performance, and its interpretation of recent trends.

Past Performance. In the past, the FAA's long-range air traffic projections have averaged 50 percent or more above the levels that actually materialized. In 1968, for example, the FAA forecast that 61 percent more aircraft would use en route navigation services in 1980 than actually occurred, 33 percent more take-offs and landings, and 63 percent more aviation fuel consumption. The last verifiable long-range (12-year) forecast was made in 1970, however, and evidence suggests that the FAA's forecasting record has improved. Examination of the FAA's medium-term (five-year) projections reveals substantially more accurate results (see Appendix C). Within this general improvement, however, FAA forecasts have been better in some areas than in others. Its forecasts of general aviation traffic--which accounts for roughly two-thirds of all anticipated growth--have been somewhat less accurate than its forecasts of total civilian aircraft traffic.

Trend Interpretation. The FAA's interpretation of recent trends in passenger travel and general aviation aircraft ownership underlies its forecast of the demand for air traffic control services. Critically, the FAA assumes continuation of the past relationship of the growth of passenger travel and the ownership of private planes to the economy as a whole. This results in forecasts that appear as rough extensions of past trends (see Figures 3 and 4).

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2. See Office of Technology Assessment, Review of the National Airspace System Plan (August 1982); and General Accounting Office, Examination of the Federal Aviation Administration's Plan For The National Airspace System--Interim Report (April 20, 1982).

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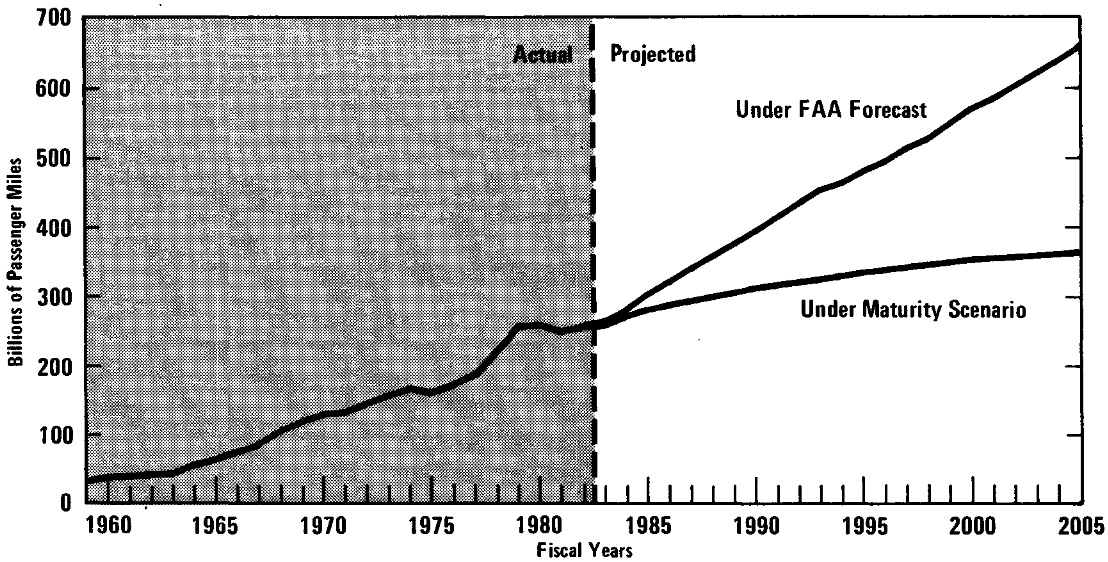
Figure 3.

Actual and Projected Commercial Airline Passenger Miles, 1959-2005 (In billions)



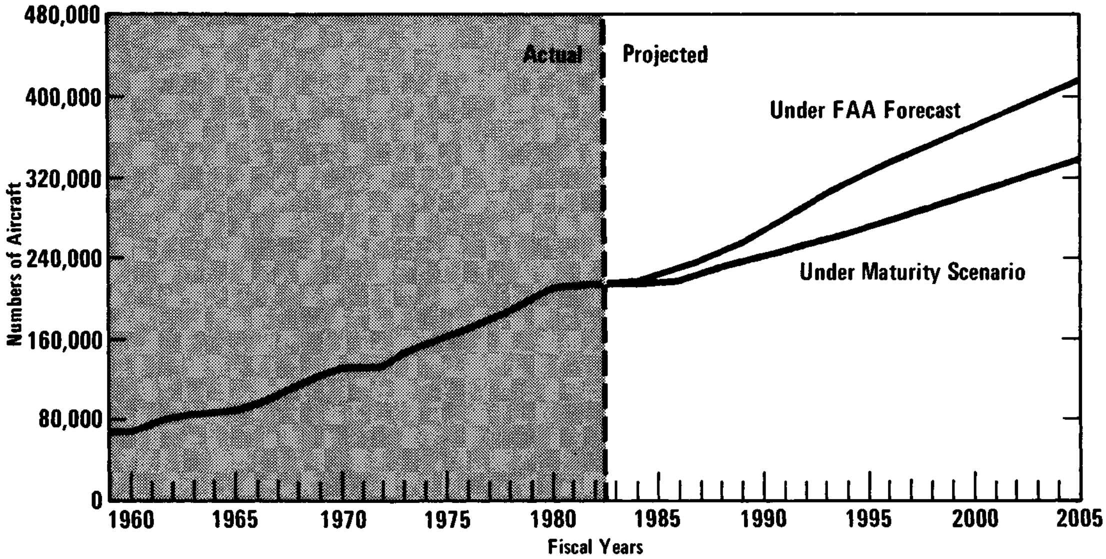
SOURCES: Congressional Budget Office and Federal Aviation Administration.

The CBO's statistical analysis of recent trends (see Appendix C) suggests the possibility that the demand for aviation services could mature and grow at a slower rate than the FAA assumes, because of gradually diminishing demand for commercial air travel and for privately owned airplanes. Similar cycles have affected other markets, such as that for automobiles. A market that is "mature," or saturated, is one in which major future growth in sales is not to be anticipated. Substantial growth in numbers of new consumers is not expected to exceed population growth. Whereas the statistical evidence that the aviation industry is indeed approaching maturity is no stronger than that underlying a projection of a resurgence of growth (see Appendix C), a "maturity scenario" represents a particularly stringent, and therefore useful, test to which to subject the

Figure 4.

Actual and Projected General Aviation Activity, 1959-2005

(In numbers of aircraft)



SOURCES: Congressional Budget Office and Federal Aviation Administration.

FAA plan for evaluating its economic worth. 3/ Under such a maturity scenario, the demand for air traffic control services could fall below FAA projections by 11 percent in 1987, by 20 percent in 1993, and by 30 percent in 2005.

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3. Compared to forecasts made by commercial aircraft manufacturers, the FAA forecasts are in the central to low range. The manufacturers' forecasts probably reflect marketing targets, however, making such comparisons difficult. But at least one commercial manufacturer (Rolls Royce) forecasts that the U.S. airline industry has already reached about 60 percent of its mature size.

Lower than expected growth in air traffic would diminish--but not completely eradicate--the projected benefits of the FAA modernization plan. Since the FAA's operating and maintenance costs in the absence of modernization would grow more or less in line with air traffic, lower growth would reduce the potential for cost savings with modernization. Even with no traffic growth, however, modernization would yield some cost savings because of increased productivity in handling current traffic levels. In fact, the FAA plan estimates that, of the $24 billion in operating and maintenance cost savings expected over the next 20 years, about half would occur irrespective of traffic growth, and half is roughly proportional to that growth. Thus, lower than projected air traffic would have a less than proportional effect on the expected savings in FAA operating and maintenance costs. For example, if the demand for air traffic service in 1993 turned out to be 20 percent below the FAA projection (as under the maturity scenarios), then cost savings would be only about 10 percent lower.

On the other hand, projected benefits to commercial and general aviation in the form of fuel savings and shortened flight times would be more or less proportional to traffic growth. Thus, the influence of possible forecasting errors on the economic performance of the FAA modernization scheme would depend on the relative importance of productivity improvements versus user benefits in the overall plan.

Effects on the FAA Plan. Even under the slower traffic growth implicit in a maturity scenario, the overall annual rate of return on investment in the FAA plan would exceed 20 percent, and discounted benefits would exceed discounted costs by about $6.8 billion over the projection period (see Table 6). The FAA plan appears cost-effective with lower forecasts for two reasons. First, system modernization and consolidation could yield productivity improvements sufficient to reduce FAA operating costs even if there were no growth in traffic. Second, projected divergence between the FAA forecast and the maturity scenarios emerges gradually, with the bigger differences occurring in the mid-1990s and beyond. The cumulative process of discounting future benefits (see Appendix D), however, diminishes the economic significance of these different projections, especially as the separation between them widens in more distant years.

Capital Costs

Although CBO has not made a detailed assessment of FAA's cost estimates, cost overruns are common in both private and public investments. Higher costs would of course diminish the plan's value, but the overruns would have to be quite large to cause its economic failure. (Though unlikely

TABLE 6. EFFECTS OF ALTERNATIVE TRAFFIC FORECASTS ON EVALUATION OF THE FAA PLAN, 1982-2005

	Return on Investment			Timing
Forecasts	Rate of Return (In percents)	Benefit-to-Cost Ratio a/	Benefits Minus Costs (In billions of dollars) a/	Return in the First Year After Completion (In percents)
Under FAA Assumptions	24.3	2.3:1	9.1	14.9
Under Maturity Scenario	21.3	2.0:1	6.8	13.1

SOURCE: Congressional Budget Office and FAA data.

a. Benefits and costs are discounted to their 1982 values at the annual rate of 10 percent.

to endanger the plan's investment value, cost overruns could cause significant financial difficulties in its implementation. This problem is dealt with in Chapter IV.) For example, a 25 percent cost overrun would still yield cumulative net benefits of $5 billion over the projection period, even with lower traffic than forecast. In fact, capital costs would have to double before the costs exceeded the benefits, even with the lower traffic forecasts (see Table 7).

Technological Change

Another risk common to projects of this type is that technological advances can render new facilities obsolete before their full benefits have been realized. Although the FAA plan calls for the introduction of "state-of-the-art" computer hardware and software technology, rapid technological developments could make such equipment obsolete before the end of its

TABLE 7. EFFECTS OF ALTERNATIVE CAPITAL COST ASSUMPTIONS ON EVALUATION OF THE FAA PLAN, 1982-2005

Alternative Capital Cost Assumptions	Return on Investment: Rate of Return (In percents)	Return on Investment: Benefit-to-Cost Ratio a/	Return on Investment: Benefits Minus Costs (In billions of dollars) a/	Timing: Return in the First Year After Completion (In percents)
Under FAA Assumptions	24.3	2.3:1	9.1	14.9
Cost Contingency of 25 percent	19.6	1.9:1	7.3	11.9
Maturity Scenario and Cost Contingency of 25 percent	17.1	1.6:1	5.0	10.5

SOURCE: Congressional Budget Office and FAA data.

a. Benefits and costs are discounted to 1982 values at the annual rate of 10 percent.

currently planned economic life. The CBO analysis indicates, however, that from an economic point of view the FAA plan is reasonably safe from the risks of technological obsolescence. Even with lower than projected traffic, if the equipment were to be replaced again in the mid-1990s (rather than early in the twenty-first century, as is planned), cumulative net benefits would still be positive--somewhat over $2 billion. Although this is below the $9 billion of net benefits the FAA assumes, it remains an acceptable investment, with an annual rate of return of about 16 to 17 percent (see Table 8).

TABLE 8. EFFECTS OF TECHNOLOGICAL OBSOLESCENCE ASSUMPTIONS ON EVALUATION OF THE FAA PLAN, 1982-2005

Assumptions	Return on Investment: Rate of Return (In percents)	Benefit-to-Cost Ratio a/	Benefits Minus Costs (In billions of dollars) a/	Timing: Return in the First Year After Completion (In percents)
Under FAA Assumptions	24.3	2.3:1	9.1	14.9
Technological Obsolescence by Mid-1990s	20.0	1.5:1	3.3	14.9
Maturity Scenario and Technological Obsolescence by Mid-1990s	16.5	1.3:1	2.1	13.1

SOURCE: Congressional Budget Office and FAA data.

a. Benefits and costs are discounted to 1982 values at the annual rate of 10 percent.

Effectiveness of Major Components

Although the FAA plan as a whole appears to offer the nation a good return on its money, questions might be raised about individual components. One important part of the FAA plan is the microwave landing system, the new instrument landing device that allows shorter flight times by reducing the approach path for incoming aircraft (see Chapter II). The economic worth of the microwave landing system (MLS)--projected to cost $2.3 billion over the next two decades--depends on the monetary value assigned to the time gained as a result of reduced delay. As stated in Chapter II, time is an economic resource with somewhat elusive value. The FAA, having equated the value of time to passengers' hourly earnings, estimates the net benefits of the microwave landing system to total $583 million. If the lower value of 30 percent of hourly earnings suggested by other analysts (see Appendix E) is applied, the microwave landing system, under the lower than projected traffic scenario, would be estimated to "lose" $177 million, since discounted costs would exceed discounted benefits by that amount (see Table 9). On the other hand, this ignores unquantifiable benefits expected with MLS, in the form of diminished noise and air pollution (see Chapter II).

TABLE 9. EFFECTS OF ALTERNATIVE ASSUMPTIONS ON EVALUATION OF THE MICROWAVE LANDING SYSTEM, 1982-2005

	Return on Investment		
Assumptions	Rate of Return (In percents)	Benefit-to-Cost Ratio a/	Benefits Minus Costs (In millions of dollars) a/
Under FAA Assumptions	19.8	1.6:1	583.0
Time Savings Valued at 30 percent of Passengers' Earnings	10.8	1.0:1	38.6
Maturity Scenario and Time Savings Valued at 30 percent of Passengers' Earnings	6.0	0.8:1	-176.9

SOURCE: Congressional Budget Office and FAA data.

a. Benefits and costs are discounted to 1982 values at the annual rate of 10 percent.

This suggests a possible mid-course, namely selective rather than system-wide application of the microwave landing system. Indeed, for certain specific problems, introduction of the microwave landing system might offer substantial and cost-effective relief. For example, improved signal reliability with the microwave landing system could allow safe landings in difficult siting situations. This means, for example, that airports located in mountainous terrain could provide precision landing aids where none are now available. Since airlines cannot offer regularly scheduled service unless precision guidance is available, the system could offer important economic benefits to certain communities. In addition, microwave landing systems could improve airport capacity use in certain large metropolitan areas. 4/

On the other hand, selective application of the microwave landing system could mean that some aircraft would need to carry both current and modernized avionics equipment. These costs would have to be weighed against the advantages of an approach that would introduce the microwave landing system selectively.

Pricing Policy

The FAA plan assumes that the current structure of federal user fees would remain in place as the chief financing mechanism for the National Airspace System Plan. Of the total federal cost of the plan (about $7.6 billion in 1982 dollars), an estimated 30 percent, or $2.3 billion, is attributed to general aviation. 5/ Over the plan's entire implementation period, however, general aviation user fees (taxes of 12 cents per gallon of

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4. See Mitre Corporation, Potential MLS Applications to Airport Capacity (November 1982). For example, when poor weather conditions require instrument approaches, landings at Kennedy Airport's runway 31 (two parallel runways, 31 right and 31 left) are limited to one runway or alternating runways even though these parallel runways are sufficiently far apart to permit their simultaneous use. This is because current landing aids could not guide two aircraft simultaneously if both blunder on the approach and need to circle around and try again. The microwave landing system, however, could double the landing capacity of runway 31 by providing more precise guidance that allows two aircraft to fly out on independent paths.

5. Based on cost allocation factors in Federal Aviation Administration, Financing the Airport and Airway System: Cost Allocation and Recovery (November 1978).

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gasoline and 14 cents per gallon of jet fuel) would generate only about $900 million, 6/ some of which would be used to finance airport improvements rather than the FAA plan. The gap in revenues would be made up by the ticket taxes paid by commercial airline passengers.

The result could be support from airline passengers for the benefits received by general aviation users, a situation commonly called "cross-subsidization." 7/ Even if general aviation were to pay its proportional share, however, the FAA plan appears cost-effective. Elimination of cross-subsidies from commercial air travel to general aviation would indeed require a very significant increase in the latter's user fees; such an increase would likely result in a substantial reduction in their demand for air traffic control services and thus in reduced benefits from the FAA plan. Nonetheless, the nongeneral aviation benefits of the FAA plan appear sizable enough to ensure a rate of return of 17 percent to 18 percent, even if three-fifths of all general aviation flights were eliminated by user charges set high enough to recover general aviation's full share of the costs of the control system.

A still more efficient plan for system modernization, however, might be possible under a system of full cost recovery. Presumably, reduced general aviation demand would permit fewer or less costly flight service stations and other general aviation services. Moreover, if higher fees were introduced soon, the capacity of today's air route center computers would be exhausted later than is now anticipated. This, in turn, could permit a more efficient schedule of air route center modernization. In particular, rather than introducing new computers now, the FAA could await the development of further advanced software and ensure that any new hardware is fully compatible.

On the other hand, a sudden shift to full cost recovery could exact high transition costs, such as reduced employment in the general aviation industry, and such costs would need to be weighed against the benefits of a different approach to computer replacement. Inasmuch as the computer replacement program is already underway, the use of a sudden increase in user fees to moderate the program would probably not be desirable.

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6. Based on U. S. Treasury forecasts.

7. See Congressional Budget Office, Public Works Infrastructure, Chapter VII on "Airports," which offers further information on the structure of user-fee financing of airports and cross-subsidies among airport users.

THE RISK OF ECONOMIC FAILURE

Although it is instructive to explore the potential effect of errors in individual assumptions one at a time, several such errors would inevitably occur simultaneously. At the most pessimistic extreme, for example, one can compute the rate of return under a "worst case" condition. If the worst cases in all assumptions reviewed above were combined, the rate of return for the FAA plan would be only 2.8 percent. But this approach is also of little practical value, simply because the possibility of everything's going wrong seems just as remote as the possibility of everything's going as initially assumed.

A better guide to the risk associated with an investment is given by the estimated probability, or chance, that the rate of return will fall below 10 percent (the OMB minimum standard). This probability is estimated by assigning ranges (that is, probability distributions) to the various outcomes for each individual parameter, and then making repeated rate-of-return calculations using assumptions drawn at random from each range. This procedure generates not a point estimate but a probability distribution for the rate of return.

On the basis of ranges that CBO estimates for productivity improvements, fuel savings, capital costs, and benefits from the microwave landing system, the FAA plan has a 20 percent probability of falling below the 10 percent rate-of-return mark (as shown in the table below). There is, however, considerable skew toward the 10 percent to 15 percent range in the overall probability distribution of the rate of return. This means that the average or expected value is a 13.5 percent return--considerably lower than the 24 percent rate of return calculated from FAA assumptions, and not far above the OMB minimum standard.

Thus, though the risk of economic failure appears fairly small, it is not insignificant, and steps to help minimize it might be in order. This chapter concludes with a brief discussion of options that could help avert a poor economic return from so large a public investment.

Managing the Risks--Congressional Options

What can the Congress do to make sure that the National Airspace System Plan achieves its objectives in a cost-effective and timely manner? Two related and key variables associated with the plan's success--system consolidation and staff reduction--are readily controllable by the Congress, giving ready access to two options.

RISK ANALYSIS FOR THE
NATIONAL AIRSPACE SYSTEM PLAN

Possible Rates of Return (In percents)	Chance of a Lower Rate of Return (In percents) a/
2	6
6	7
10	20
15	70
20	97

NOTE: The following assumptions are reflected:

- o Average capital costs are 25 percent higher than FAA assumptions, with a standard deviation of 10 percent;
- o Average productivity improvements are one-third below FAA forecasts, with a standard deviation of 15 percent;
- o Air carrier fuel savings fall 20 percent below FAA forecasts, with a standard deviation of 20 percent;
- o General aviation fuel savings fall 40 percent below FAA forecasts, with a standard deviation of 20 percent; and
- o Benefits from the microwave landing system fall 25 percent below FAA forecasts, with a standard deviation of 25 percent.

a. The distribution mean rate of return is 13.5 percent. The distribution standard deviation is 4.1 percent.

First, the Congress could ensure that the FAA is allowed to close facilities according to its plan. As mentioned earlier, the Congress has refused to allow consolidation in the past, in some instances because of local employment implications. Though legitimate public policy concerns, these issues could impede progress in making the facility consolidations critical to the FAA plan's economic success.

Second, the Congress could make the FAA's planned schedule for consolidation and staff reductions part of the appropriations process. This could include setting progressively lower appropriations in line with the projected savings in operating costs, thus creating an incentive for the FAA to consolidate facilities and reduce staff according to schedule. Obviously, if slippages did occur, the FAA would have to seek supplemental appropriations to meet a revenue shortfall. Nevertheless, the rationales for such supplemental appropriations would have to be spelled out, thereby providing a device for monitoring FAA's progress in implementing the plan.