THE ECONOMICS OF AIRLINE SAFETY AND SECURITY: AN ANALYSIS OF THE WHITE HOUSE COMMISSION'S RECOMMENDATIONS

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After over a year of investigation and the recovery of ninety-five percent of the wreckage, we still do not know the exact cause of the tragic crash of TWA flight 800.[1] The Federal Bureau of Investigation (FBI), however, has virtually ruled out the possibility of a terrorist act as the cause of the disaster.[2] The Administration quickly reacted to the incident by immediately implementing several heightened security measures and creating a White House Commission on Aviation Safety and Security (the Commission). President Clinton asked this Commission to take a comprehensive look at the state of safety and security in aviation and make recommendations for improvement. After just forty-five days, the Commission issued an initial report with recommendations for ambitious changes to airport security. On February 12, 1997, the Commission issued a final report containing no less than fifty-seven proposals aimed at improving aviation safety and security.[3]

1. TWA flight 800 crashed on July 17, 1996, off the Long Island coast en route to Paris from John F. Kennedy Airport. *See* Don Phillips, *Witnesses Say They Saw Fireball Fall*, WASH. POST, July 18, 1996, at A1. The National Transportation Safety Board is still conducting hearings to identify the cause of the crash. *See also* Don Phillips & Paul W. Valentine, *No Evidence of Attack, NTSB Told*, WASH. POST, Dec. 9, 1997, at A3.

2. The FBI has found no evidence of a criminal act in the downing of TWA flight 800. The criminal investigation is now considered inactive. *See* Roberto Suro, *Crime All but Ruled Out in TWA Crash*, WASHINGTON POST, Nov. 19, 1997, at A1.

3. "Safety" measures are targeted at reducing the risk of accidents. "Security" measures are targeted at reducing the risk of criminal acts such as hijackings and sabotage.

The initial recommendations alone will cost billions of dollars to implement and could cause extensive delays at the airports. President Clinton assures us that as a result of implementing the initial security proposals, "not only will the American people feel safer, they will be safer."[4] But is this really true? The White House has neither given a clear indication of the effectiveness of these measures in preventing terrorist acts nor acknowledged the true cost of implementation.

Although the Commission states that "Americans should not have to choose between enhanced security and efficient and affordable air travel," difficult trade-offs occur in reducing risks.[5] Each measure to improve safety and security can increase the direct costs to travelers, cause delays and inconvenience, infringe on civil liberties, increase taxpayer costs, and even increase fatalities. For example, using high-tech machines may detect some explosives in checked luggage, but the devices are costly and far from foolproof. Requiring airlines to match each bag to a passenger may reduce the threat of a "drop-and-run" terrorist tactic, but it could cause lengthy delays and inconvenience. Using computer background checks to identify suspected terrorists could enhance security at a reasonable cost, but it would also curtail individual freedoms. Mandating child safety seats will secure infants during air travel, but the higher costs could lead to an increase in automobile travel and highway fatalities.

Improving air safety and security are important, but we need to assess the cost and effectiveness of each measure before we spend billions of taxpayers' and travelers' money on safety and security measures. Moreover, we need to confront the question of how safe is safe enough.[6] The sad truth is that aviation fatalities cannot be eliminated unless we ban air travel, and that is simply too high a price to pay. Therefore, some level of risk must be deemed acceptable.

This Article provides a framework for thinking about these risk trade-offs by using economic analysis to examine the costs

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4. William J. Clinton, *Remarks Announcing Counterterrorism Initiatives and an Exchange with Reporters*, 1684 WKLY. COMPILATION PRESIDENTIAL DOCUMENTS 32 (Sept. 16, 1996).

5. WHITE HOUSE COMM'N ON AVIATION SAFETY AND SECURITY, FINAL REPORT TO PRESIDENT CLINTON 25 (1997) [hereinafter WHITE HOUSE COMM'N, FINAL REPORT].

6. *See generally* LESTER B. LAVE, THE STRATEGY OF SOCIAL REGULATION: DECISION FRAMEWORKS FOR POLICY (1981).

and benefits of selected Commission recommendations for enhancing safety and security. First, it reviews some key points from the final report of the Commission, highlighting potential problems. The Article then gives a careful evaluation of the impacts of some security measures proposed by the Commission. Finally, it offers some general guidance on the development of policies aimed at improving safety and security.

I. THE WHITE HOUSE COMMISSION RECOMMENDATIONS

High-profile airline disasters such as the TWA flight 800 crash sparked great media coverage and public concern over the safety and security of the U.S. airline industry. A total of 380 people perished from these incidents in 1996, the highest number in ten years.[7] It is important, however, not to make conclusions about the safety trends in aviation based on year-to-year changes in accident rates. The fatal accident rate fluctuates greatly from year to year, but overall it has declined significantly over the last few decades.[8] As Figure 1 illustrates, the accident rate has declined from 0.011 fatal accidents per million aircraft miles flown in 1960 to 0.0005 in 1995.[9] In fact, as the Commission notes, commercial aviation is the safest mode of transportation.[10]

Nonetheless, the Commission has recommended fifty-seven changes to commercial aviation. These proposals are comprehensive, covering four major areas of the aviation industry. The report contains fourteen recommendations for improving aviation safety, six for air traffic control, thirty-one (including twenty from the initial report) for security, and six for responding to aviation disasters.

One of the most disturbing aspects of the report is the lack of a serious discussion of the costs and benefits that would result from implementation of the recommendations. The

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7. *See* NATIONAL TRANSP. SAFETY BD., NUMBER OF MAJOR AIRLINE ACCIDENTS, DEATHS RISE; GENERAL AVIATION HAS LOWEST FATAL ACCIDENT RATE 1 (Feb. 21, 1997) [hereinafter NATIONAL TRANSP. SAFETY BD., DEATHS RISE].

8. *See* CLINTON V. OSTER, JR. ET AL., WHY AIRPLANES CRASH 5-7 (1992).

9. This calculation is based on National Transportation Safety Board (NTSB) data of scheduled passenger airline service with 30 or more seats. *See* NATIONAL TRANSP. SAFETY BD., DEATHS RISE, *supra* note 7, at tbl.5; BUREAU OF TRANSP. STATISTICS, U.S. DEP'T OF TRANSP., NATIONAL TRANSPORTATION STATISTICS: 1993 ANN. REP. 74 (1993).

10. *See* WHITE HOUSE COMM'N, FINAL REPORT, *supra* note 5, at 7.

Commission recommends that "cost alone should not be dispositive in deciding aviation safety and security rulemaking issues."[11] The language is obscure, but the message is clear: cost-benefit analysis should not play an important role in regulating air safety and security. The General Accounting Office (GAO) cautions that this proposal is a significant departure from the current rulemaking process and could lead to expensive policies yielding only small gains in safety.[12]

Many of the proposals, such as making the Federal Aviation Administration (FAA) rules performance-based, appear sensible. Several, however, have significant potential impacts on the economy and travelers' welfare that are not adequately explored in the Commission's final report. For example, the Commission recommends setting a national goal of reducing the accident rate by 80 percent within a decade.[13] Such a goal may not be achievable or may only be achievable at an enormous cost given the already low rate of aviation accidents in the United States. The report, however, makes no attempt to recognize the costs associated with this goal or discuss who would pay for achieving the accident reduction.

The Commission also recommends acceleration of the National Airspace System modernization in order to make the modernized system operational by the year 2005, seven years ahead of the current plan.[14] Considering that prior to the 1994 reforms, this program was eight years behind schedule and $5 billion over budget, meeting the new goal will be an expensive task.[15]

The costs of some recommendations aimed at improving safety and air traffic control may be justified by the potential benefits.[16] Historically, pilot error has been the top contributor

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11. *Id.* at 12.

12. *See Aviation Safety and Security: Challenges to Implementing the Recommendations of the White House Commission on Aviation Safety and Security: Testimony before the Subcomm. on Aviation of the Senate Comm. on Commerce, Science and Transp.*, 105th Cong. 20 (1997) (statement of Gerald L. Dillingham, Associate Director, Transportation Issues, Resources, Community, and Economic Development Division, U.S. General Accounting Office).

13. *See* WHITE HOUSE COMM'N, FINAL REPORT, *supra* note 5, at 3.

14. *See id.* at 19.

15. *See id.* at 17.

16. The Commission noted that if the frequency of accidents remains the same, the projected increase in air traffic will increase the total number of accidents. *See id.* at 7.

to fatal commercial accidents, followed by weather and traffic control.[17] Hence, actions to make improvements in these areas may be warranted. On the other hand, given the relatively low risk of airline terrorism, it would be difficult to justify the costs of extensive security measures.[18] Even the Commission recognizes that "although the threat of terrorism is increasing, the danger of an individual becoming a victim of a terrorist attack—let alone an aircraft bombing—will doubtless remain very small."[19]

Nevertheless, the Commission's initial report made twenty recommendations for tightening the security system and recommended eleven additional measures in its final report. The initial recommendations and the status of their implementation are summarized in Table 1. The table reveals that almost no information has been provided on the expected costs of the various recommendations; instead, budget requests were provided. Congress incorporated these budget requests into two 1997 appropriations bills and the FAA Reauthorization Act that the president signed into law.[20]

Adopting these recommendations could lead to regulations that are both ineffective and inefficient. As the following sections on costs and benefits of the proposed security measures will show, implementation of stringent security measures could cost billions of dollars and also increase overall fatalities.

Boeing projects that if global accident rates are not reduced, an airliner will crash somewhere in the world almost weekly by 2015. *See id.* The Commission also reported an Air Transport Association estimate that inefficiencies in the air traffic control system cost airlines over $3 billion in 1995. *See id.* at 17.

17. *See* Steven Morrison & Clifford Winston, *Air Safety, Deregulation, and Public Policy*, THE BROOKINGS REVIEW, Winter 1988, at 10, 12 [hereinafter Morrison & Winston, *Air Safety*].

18. Analysis of historical data shows that there is less than a one-millionth of one percent chance that any given piece of luggage contains a bomb. *See* OSTER, *supra* note 8, at 148.

19. *See* WHITE HOUSE COMM'N, FINAL REPORT, *supra* note 5, at 23.

20. The Omnibus Appropriations Act of 1997 provided funding to the FAA to finance security measures such as bomb sniffing dogs, airport vulnerability assessments, additional security personnel, and the purchase and installation of bomb detection equipment, as well as further security research. *See* Omnibus Appropriations Act of 1997, Pub. L. No. 104-208, § 5402, 110 Stat. 3009, 3009-511 (1996). The Federal Aviation Reauthorization Act of 1996 directed the FAA to certify screening companies, improve training of security screeners, require criminal background checks for baggage screeners, deploy commercially available bomb detection machines, continue to use passenger profiling, and prepare studies on screening technologies as well as domestic bag matching. *See* Federal Aviation Reauthorization Act of 1996, Pub. L. No. 104-264, § 301(a), 110 Stat. 3213, 3250 (1996).

II. Evaluation of the Impact of Some Security Measures Proposed by the Commission

A. *Costs*

In the post-TWA crash world, airline travelers can easily tell you the costs that they endure. Due to the heightened security measures instituted by the FAA, passengers are asked to arrive at airports earlier, stand in longer lines, answer more questions about the contents of their carry-on bags, and show photo identifications before boarding the plane.[21] Implementing the Commission's proposals would cost billions of dollars in direct implementation costs and lead to even more lines and delays.

Some of the important and controversial proposals of the Commission have been analyzed by previous researchers, and their findings do not inspire confidence. Examples include the use of explosive detection devices, full passenger-bag match, and automated passenger profiling.

The GAO has reviewed the state of the explosive detection technologies and FAA efforts to improve airport security.[22] The GAO found that explosive screening technologies are not particularly reliable. They frequently yield false alarms and do not process baggage as quickly as claimed.[23] The FAA has certified only one explosive detection machine (the CTX 5000, with a per-machine cost of $1 million) for checked baggage screening.[24] As the certified machine has an actual throughput of much less than the designed rate of 500 bags per hour, two units are necessary to meet the FAA throughput requirement.[25]

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21. The FAA announced on July 25, 1996, that it will begin increasing the security level at U.S. airports. *See* FEDERAL AVIATION ADMIN., U.S. DEP'T OF TRANSP., FAA STATEMENT OF INCREASED SECURITY LEVELS AT U.S. AIRPORTS 1 (July 25, 1996).

22. Most documents discussing the effectiveness and cost of various security technologies and procedures are classified. The information that follows is based on the GAO's assessment of these classified documents. *See Aviation Security: Immediate Action Needed to Improve Security: Hearing Before the Senate Comm. on Commerce, Science and Transp.*, 104th Cong. 62, 64-66 (1996) (statement of Keith O. Fultz, Asst. Comptroller General for the Resources Community and Economic Development Division, U.S. General Accounting Office) [hereinafter Fultz].

23. *See id.* at 64.

24. *See id.* at 65.

25. *See Terrorism and Drug Trafficking: Technologies for Detecting Explosives and Narcotics: Briefing Report to Congressional Requesters*, 104th Cong. 7, 16 (1996) [hereinafter *Terrorism and Drug Trafficking*].

Even with two machines, there is significant potential for operator error. It seems likely, for example, that in the press of rush hour, operators will start ignoring positives to reduce the ire of travelers who do not like to wait or who may miss their flights.

Delays associated with this technology could be quite extensive. If enough machines are not deployed, significant delays may result due to slow screening of baggage. For example, the certified machine has actual throughput capacity of only 260 bags per hour.[26] In the United Kingdom, a throughput capability of 1,000 bags per hour is required to avoid flight delays.[27] To meet the U.K. standard, four machines would be necessary.[28] Even if enough machines are deployed to screen baggage at a reasonable pace, false alarms could lead to hundreds or even thousands of bags needing additional inspection.[29] If requiring this technology leads to delays, airlines may have to react by scheduling longer turnaround times in airports, resulting in decreased utilization of aircraft. This adjustment could lead to substantial increases in ticket prices. This ticket cost increase would be in addition to the increase that would result from the cost (up to $2.2 billion) of acquiring and installing these machines in the seventy-five busiest airports in the United States.[30]

Positive passenger-bag match ensures that each bag aboard every flight is accompanied by a passenger on board. If a passenger fails to board a flight, his checked luggage is removed. Passenger-bag match will prevent the "drop and run" terrorist tactic, but will not prevent passengers from being tricked into carrying explosives onto the plane and will not stop the determined saboteur who is willing to give up his own life.

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26. *See* Aviation Security and Anti-Terrorism Efforts: *Hearing Before the Subcomm. on Aviation of the House Comm. On Transp. and Infrastructure*, 104th Cong. 85 (1996) (documents submitted to the Subcommittee in support of testimony by Sergio Magistri, President and CEO of InVision Technologies Inc.).

27. *See Aviation Security and Anti-Terrorism Efforts: Hearing Before the Subcomm. on Aviation of the House Comm. On Transp. and Infrastructure*, 104th Cong. 99 (1996) (statement of David Tomlinson, Head of Group Security, BAA plc) [hereinafter Tomlinson].

28. Considering the larger scale of U.S. airport activities, the U.K. requirement of 1,000 bags per hour may be considered a lower bound for what is necessary to prevent delays in the United States.

29. *See Terrorism and Drug Trafficking*, *supra* note 25, at 6.

30. *See* Fultz, *supra* note 22, at 65.

Although the Commission recommends partial bag matching in the final report, the Administration has expressed its intention eventually to require full passenger-bag match for all flights.[31] There is cause for concern with a full passenger-bag match requirement for all domestic flights. The process of removing unaccompanied luggage could be very time-consuming. The likelihood of passengers' unintentionally missing flights may be small for international flights, but this could be a huge problem for domestic flights. If a passenger fails to board a plane, it could take several hours to remove his bags from a luggage container on a large plane.[32] In 1989, then-Transportation Secretary Sam Skinner testified to Congress that this type of requirement for domestic flights "would probably paralyze" the air transport hub system.[33] It would make it impossible to continue current schedules for quick transfer between flights at the hubs. According to one FAA estimate, implementing such a requirement could cost $2 billion annually.[34]

Currently, passenger-bag match is required by the FAA for international flights.[35] International travelers are requested to arrive two hours early to allow for all the required inspections and security measures, including bag match. If passenger-bag matching and further scrutiny of baggage by explosive detection devices for domestic flights require about the same time as current procedures for international flights, each domestic

31. *See* OFFICE OF THE PRESS SECRETARY, THE WHITE HOUSE, PRESS BRIEFING BY MIKE MCCURRY AND DR. ELAINE KAMARCK 5-6 (Feb. 12, 1997).

32. *See* Barton Gellman, *El Al's Security: Pace-Setting and Pace-Slowing*, WASH. POST, Aug. 6, 1996, at A11 (reporting a statement by Tuvia W. Livneh, Israel's El Al Airport's Security Chief from 1987 to 1993).

33. *See Aviation Security: Hearing Before the Subcomm. on Transp. and Related Agencies of the Senate Comm. on Appropriations*, 101st Cong. 29 (1989) (statement of Samuel K. Skinner, U.S. Secretary of Transportation).

34. The GAO reports a figure of $2 billion for startup costs and lost revenue. *See* GENERAL ACCOUNTING OFFICE, BRIEFING REPORT TO CONGRESSIONAL REQUESTERS: TERRORISM AND DRUG TRAFFICKING: THREATS AND ROLES OF EXPLOSIVES AND NARCOTICS DETECTION TECHNOLOGY 11 (1996). This is a rough estimate and does not appear to account for cost of delays to air travelers. At this point it is not at all clear what the actual cost of implementing full passenger-bag match would be.

35. According to one FAA official, all airlines under FAA jurisdiction are required to include passenger-bag matching for international flights in their security plan. *See* Telephone Interview by Fumie Yokota, Research Assistant, American Enterprise Institute, with Mark Hess, Special Information Office, Public Affairs Office, Federal Aviation Administration (Oct. 17, 1996).

passenger could spend at least an additional hour in the airport. But considering the larger scale of the domestic market (international passengers account for less than ten percent of U.S. carriers' passengers), actual delays could be much greater.[36]

The positive bag match requirement and the new explosive detection technology introduce an important delay cost that is not easily quantified—the anxiety of missing one's flight or a connecting flight because of unpredictable security delays. This cost has not been explicitly considered in any of the proposals endorsed by the Commission, even though it is likely to be significant in some cases.

Automated passenger profiling would use a computer database containing information on passenger characteristics to help identify those individuals most likely to be potential terrorists. This process, which is endorsed by the Commission, could reduce the number of bags that must be further scrutinized by up to 80 percent and may be a cost-effective approach to reducing terrorism.[37] But there are some significant potential problems with its implementation. The American Civil Liberties Union (ACLU) protests the use of profiling, arguing that it is unreliable and discriminatory. As the ACLU pointed out in testimony before the Commission, the actual saboteur does not always fit the profile of a terrorist.[38] There have also been cases where passengers who "fit the profile" of a terrorist have been detained and questioned for hours, even though they were not guilty of wrongdoing.

Although President Clinton requested and received from Congress over $400 million to implement the initial proposals in 1997, the actual annual cost of implementation would be in the billions. As previously noted, implementing full passenger-bag match alone could cost $2 billion annually, and the initial cost of deploying explosive detection devices to screen checked

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36. For data regarding the relative size of the international market, see AIR TRANSP. ASS'N, 1996 ANN. REP. 2 (1996).

37. *See Terrorism and Drug Trafficking, supra* note 25, at 6. The security system of Israel's El Al Airlines relies on profiling to reduce the number of bags they must screen. *See* Letter from David Swierenga, Chief Economist, Air Transport Association of America, to Robert W. Hahn (Oct. 28, 1996) (on file with author).

38. *See* GREGORY T. NOJEIM, AMERICAN CIVIL LIBERTIES UNION, STATEMENT ON CIVIL LIBERTIES IMPLICATIONS OF AIRPORT SECURITY PASSENGER PROFILING BEFORE THE INTERNATIONAL CONFERENCE ON AVIATION SAFETY AND SECURITY IN THE 21ST CENTURY 4-6 (1997).

baggage is $2.2 billion. Moreover, the initial cost of machines designed to screen passengers for explosives is estimated to be $1.9 billion.[39]

B. *Delay Costs*

Even more significant are the costs from the delays imposed by the proposed security changes on the 390 million trips taken annually on U.S. airlines.[40] A rough calculation of the annual costs of the inconvenience would multiply the total number of extra hours spent waiting at the airport by the value of air passengers' time.

The delay passengers experience depends on particular policies. For example, the FAA and the airlines recommended arriving at the airport an additional thirty minutes early for each flight because of the increased security measures implemented in July of 1996. This was probably an upper bound for the actual delay experienced by travelers as the system adjusted to the new measures. However, it is not unreasonable to assume that delay could increase by an hour if stringent measures endorsed by the Administration are fully implemented. In the discussion below, three estimates of average delay—fifteen minutes, thirty minutes, and one hour—are used to illustrate the potential impact of existing and proposed measures.

The cost of waiting depends on whether travel is for business or pleasure. The FAA uses a value of time of $37 an hour for business travelers and $32 an hour for nonbusiness travelers in 1987 dollars for evaluating investments and regulatory programs.[41] The values are based on an FAA study that estimated, based on the results of various studies, a ratio of the value of time to the wage rate and applied it to the average wage

39. The cost estimate is based on providing 3,000 of these devices, which are being developed by the FAA and the Department of Defense. *See* Fultz, *supra* note 22, at 66.

40. There were approximately 547 million enplaned passengers on U.S. scheduled airline service for both domestic and international travel in 1995. *See* AIR TRANSP. ASS'N, *supra* note 36, at 2. Adjusting for connecting passengers yields an estimate of 390 million one-way trips. For details on the conversion, see app., *infra* at 811.

41. *See* FEDERAL AVIATION ADMIN., U.S. DEP'T OF TRANSP., ECONOMIC VALUES FOR EVALUATION OF FEDERAL AVIATION ADMINISTRATION INVESTMENT AND REGULATORY PROGRAMS i (1989) [hereinafter FEDERAL AVIATION ADMIN., ECONOMIC VALUES].

rate for passengers in various user groups.[42] To update the figure over time, the FAA suggests using the "GNP Implicit Price Deflator for Total Personal Consumption Expenditures."[43] Using this method, the value of time in 1995 dollars becomes $48 an hour for business travelers and $42 an hour for nonbusiness travelers.[44]

A report prepared for the Department of Transportation calculated the value-of-time savings for intercity air travelers using an intercity mode choice model.[45] The model is based on data from trips under 500 miles for several intercity corridors. The implied value of time for the pooled corridor that includes New York State, Florida, parts of Canada, and Texas is $51 an hour for business travelers and $27 an hour for nonbusiness travelers in 1992 dollars.[46] The value of time updated to 1995 dollars is approximately $55 an hour for business travelers and $29 an hour for nonbusiness travelers.

A study by Morrison and Winston evaluated the value of time for air travelers to be $34 an hour in 1983 dollars.[47] This estimate is derived from a multinomial logit airline choice model based on data on round trips taken in five randomly selected markets. The model did not distinguish between business and nonbusiness travelers. The value of time updated to 1995 dollars is $50 an hour.[48]

These value-of-time estimates yield costs in the range of $8 billion to $10 billion per year for a thirty-minute delay (see Table 2).[49] Even if the FAA's value-of-time estimate were halved,

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42. A better measure would be the airline passengers' value of time waiting at the airport, but a good estimate of this specific value is not available.

43. *See* FEDERAL AVIATION ADMIN., ECONOMIC VALUES, *supra* note 41, at 122.

44. *See* COUNCIL OF ECONOMIC ADVISERS, ECONOMIC REPORT OF THE PRESIDENT 352, tbl.B-3 (1993). All three value-of-time estimates used in the calculations were converted to 1995 dollars using the FAA's approach.

45. *See generally* Daniel Brand, *The Values of Time Savings for Intercity Air and Auto Travelers for Trips under 500 Miles in the U.S.* (June 1, 1996) (draft report produced for the Panel on the Value of Time for use in Transportation Investment Evaluation, Department of Transportation) [hereinafter Brand].

46. *See id.* at 5.

47. *See* Steven A. Morrison & Clifford Winston, *Enhancing the Performance of the Deregulated Air Transportation System*, *in* BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS 61, 66 (Martin N. Baily & Clifford Winston eds., 1989) [hereinafter Morrison & Winston, *Enhancing Performance*].

48. *See supra* note 44.

49. In 1995 dollars, the Brand estimate yields an annual cost of $7.9 billion; the Morrison and Winston estimate yields a figure of $9.8 billion per year. Using the

the annual cost of a thirty-minute delay would be over $4 billion. The fact that people will choose not to fly—and either to stay at home or to use other forms of transportation—as air travel becomes more costly would reduce delay costs by about three percent.[50]

The preceding delay cost estimates do not include the costs of hiring and training additional personnel or acquiring, installing, operating, and maintaining new equipment to comply with the new mandates. Moreover, the estimate does not include the lost profits that airlines are likely to incur in the short term, nor does it include the welfare losses to air travelers who switch to other modes of travel.[51] For these reasons, the estimated range of $4 billion to $10 billion in costs probably understates the true cost resulting from a thirty-minute delay.[52] The assumed delay of thirty minutes may, however, overstate the actual delays that travelers currently experience. If, say, the initial recommendations resulted in an additional delay of only fifteen minutes, the delay costs would be halved. On the other hand, implementing more stringent security measures, such as full passenger-bag match for domestic flights, could easily cause an additional hour of delay, thus doubling the earlier delay cost estimates.[53]

Consumer Price Index instead of the GDP price index would yield estimates that are one percent to three percent larger.

50. *See infra* app. at 813-15.

51. For those people who elect not to fly, these delay cost estimates can be viewed as a maximum estimate of their loss in consumer welfare, because travelers who elect not to fly presumably get some non-negative benefit from the mode of travel they chose.

52. The additional waiting time may actually average less than 30 minutes. To the extent that it does, costs would need to be adjusted downward.

53. An hour is a reasonable estimate for the potential delays resulting from tightened security measures. Most passengers departing from Tel Aviv on El Al Airlines are requested to arrive two-and-a-half hours before the scheduled departure time to allow for the intensive security measures. *See* El Al Airlines, *Check-In, Menu of Services, At the Airport* (as of Jan. 22, 1997) <http://www.elal.co.il/services/checkin/airport.htm>. A CBS News Poll conducted soon after the TWA crash showed that, although many people favor some increase in screening at airports, eighty-four percent of fliers are not willing to spend more than an hour waiting at the airport. *See CBS News: The Crash of Flight 800* (CBS television broadcast, July 21, 1996). Fifteen percent of fliers are not willing to spend any extra time at the airport. If people are forced to wait two hours to board domestic flights, it may be the end of the low-cost, short-distance carriers such as Southwest Airlines. The potential losses in consumer welfare and airline profits are enormous.

C. *Highway Fatalities*

Although the Commission's recommendations are well-intentioned, they could result in a substantial increase in traffic fatalities. As air travel becomes more expensive or more inconvenient, people will tend to switch to other modes of transportation or to not travel at all. Because automobile travel is a more dangerous mode of transportation, the net result will be an increase in fatalities.

The Commission recommends that child-restraint systems be required for infants on commercial flights. In 1995, the FAA published a study investigating the potential effects of such a requirement on infant fatalities. The report found that the child-safety-seat requirement is likely to increase the cost to air travelers while causing a net increase in fatalities. The FAA estimates that although this requirement may save the lives of five infants over ten years (one every other year), such a requirement is likely to increase highway fatalities by 30 to 100 lives over this same time period as families choose to travel by automobile rather than by plane.[54] A former Associate Administrator for Regulation and Certification of the FAA noted in a written statement to Congress that every analysis he has seen on this requirement has shown that its implementation would result in more lives being lost than saved.[55]

Likewise, security measures that impose higher air-travel costs and longer delays are likely to make some air travelers switch to automobile travel. The impact that switching from air travel to road travel would have on the number of fatalities would depend on the elasticity of air travel and the difference in the fatality rate between air and road travel.

Morrison and Winston calculated the modal-share elasticity of air travel from an intercity demand model.[56] They found that elasticities for business and nonbusiness travelers were -0.18 and -0.38 respectively. Using these estimates as the base case and a

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54. *See* FEDERAL AVIATION ADMIN., U.S. DEP'T OF TRANSP., CHILD RESTRAINT SYSTEMS 103-305 (1995).

55. *See Concerning Aviation Safety Issues Raised in the Final Report and Recommendations of the White House Commission on Aviation Safety and Security: Testimony Before the Subcomm. on Aviation of the Senate Comm. on Commerce, Science, and Transp.*, 105th Cong. 10-11 (1997) (statement of Anthony J. Broderick, independent aviation safety consultant).

56. *See* STEVEN MORRISON & CLIFFORD WINSTON, THE ECONOMIC EFFECTS OF AIRLINE DEREGULATION 17 (1986) [hereinafter MORRISON & WINSTON, ECONOMIC EFFECTS].

range of -0.5 to -0.1 for business and -0.7 and -0.2 for nonbusiness, the expected volume of air travel that will be diverted to road travel can be calculated.

Automobile safety experts point out that simply comparing the average fatality rate for the two modes of transportation overstates the risk of automobile travel for three important reasons. First, travel on rural interstate highways, not on average roads, directly competes with air travel. Second, traffic fatalities are commonly expressed in vehicle miles (total miles traveled by a vehicle), whereas air fatality is calculated in passenger or person miles (total miles traveled by individuals). Finally, unlike air travel, traffic fatality is highly dependent on the characteristics of individual drivers.[57]

To determine the difference in risk between air travel and road travel, the fatality rate for each mode needs to be calculated. The fatality rate from accidents of scheduled air service fluctuates greatly from year to year.[58] Taking an average of fatality rates between 1985 and 1995 yields an estimate of 0.29 deaths per billion passenger miles.[59]

The fatality rate from vehicle traffic accidents is not volatile like the air fatality rate and has exhibited a slight decline over the past ten years.[60] The overall number of vehicle deaths per year was 17 per billion vehicle miles in 1994.[61] As previously noted, comparing 17 to 0.29 is not an accurate measure of the safety trade-off between air and road travel. The fatality rate of air travel needs to be compared to the fatality rate for intercity road travel.

In 1994, there were 216 billion vehicle miles traveled by all vehicles on rural interstate highways.[62] There were also a total of

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57. *See* Leonard Evans et al., *Is it Safer to Fly or Drive?*, 10 RISK ANALYSIS 239-46 (1990).

58. *See* AIR TRANSP. ASS'N, *supra* note 36, at 9. Scheduled service is defined as "Transport service operated over routes of a U.S. scheduled airline, based on published flight schedules, including extra sections." *Id.* at 18.

59. Calculation based on fatalities divided by passenger miles. *See* NATIONAL TRANSP. SAFETY BD., NATIONAL TRANSPORTATION SAFETY BOARD NEWS RELEASE: AIRLINE FATALITIES IN 1995 DECLINED TO 175 PERSONS tbl.3 (Jan. 25, 1996); AIR TRANSP. ASS'N, *supra* note 36, at 3 (passenger miles figures).

60. *See* NATIONAL HIGHWAY TRAFFIC SAFETY ADMIN., TRAFFIC SAFETY FACTS 1994: A COMPILATION OF MOTOR VEHICLE CRASH DATA FOR THE FATAL ACCIDENT REPORTING SYSTEM 15 (1995).

61. *See id.*

62. *See* FEDERAL HIGHWAY ADMIN., HIGHWAY STATISTICS 1994 V-133 (1995).

2534 fatalities on these highways, including drivers, vehicle passengers and pedestrians.[63] These figures reveal a rate of 11.7 deaths per billion miles, much lower than the rate of 17 for all vehicle accidents.

The rate of 11.7 deaths still overestimates the risk. There are large differences in the fatality risk of driving, depending on the age and gender of the driver.[64] Because the age and gender distribution of airline passengers is different from the distribution of all drivers, the fatality rate needs to be adjusted accordingly.

Evans, Frick, and Schwing found that drivers with the same age and gender distribution as airline passengers have a 24.1 percent lower risk of driver fatality than do licensed drivers in general.[65] Applying this adjustment yields a fatality rate of 8.9 deaths per billion vehicle miles.

The net effect of proposed safety and security measures on annual fatalities is calculated by combining the fatality rates previously estimated and the change in vehicle miles traveled that would result from those measures.[66] This yields an annual increase of sixty fatalities with a total range of 30 to 140, given a thirty-minute delay (see Table 3).[67] Using a value-of-time estimate half that of the FAA's would decrease the fatalities for each case by roughly half.[68] Implementation of more extensive security measures, such as full passenger-bag match, will result in substantial further delays, with a concomitant increase in costs and net fatalities.[69]

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63. *See id.*

64. *See* Evans et al., *supra* note 57, at 240.

65. *See id.*

66. For the calculation of the change in vehicle miles traveled, see *infra* app. at 814.

67. These calculations are based on the assumption of a thirty-minute delay and the value-of-time estimates used by the FAA, see *infra* tbl.2. Other costs, such as equipment and personnel costs, were not included in the calculation. The fatality figures are linearly related to the delay time, so that a fifteen-minute delay would cause half the number of fatalities that a thirty-minute delay would cause. Similarly, a sixty-minute delay would cause double the number of fatalities.

68. The relationship is not linear because fatalities depend on the percentage change in the cost of traveling by air, which is linearly dependent on delay time, but not linearly dependent on value of time.

69. These calculations are based on the assumption that miles traveled by air roughly translate into miles traveled by road, a good first approximation. This relationship, however, may not hold exactly because of two factors that work in opposite directions. Traveling on a flight with a connection at a hub, as opposed to traveling on a non-stop flight, may add significantly to the miles traveled. If this is true, these estimates tend to overstate the actual increase in road fatalities, because road miles traveled do not include

D. *Benefits*

Although the proposed measures have a clear impact on the cost and convenience of air travel, their effectiveness in preventing terrorist acts is unclear. It is extremely difficult to assess the incremental benefits of antiterrorist measures, because the baseline demand for terrorist activity cannot be directly observed. We observe the "equilibrium" outcome of the demand for terrorism and the supply of security measures. In the past five years, the number of worldwide criminal acts against civil aviation has declined significantly from 120 to 24.[70] The cause of the decline may have been due to a rise in security measures that deterred terrorists or to a general decline in terrorist activity unrelated to security measures. It is impossible to determine exactly how much of the decline is attributable to airport security measures alone.

What will these increased expenditures in time and money buy the American public in terms of security? In a "best-case scenario," these changes could eliminate or substantially reduce the threat from airline terrorism. Counterterrorism expert Michael Ledeen maintains that checking identification, tickets, and baggage more carefully is a good idea. But even with these enhanced procedures, he believes most earlier terrorist incidents would have succeeded. As noted earlier, the effectiveness of the proposed changes, especially two of the most costly measures, is questionable. Currently available explosive detection devices are not extremely reliable. Moreover, the determination of actual hazard ultimately rests on the judgment of a human operator, which the GAO finds could be a weak link in the bomb detection process.[71] Likewise, the passenger-bag match requirement cannot stop a bag belonging to a passenger who has been tricked into carrying explosives from boarding a plane, nor stop a terrorist on a suicide mission. Moreover, these measures focus on the threat of bombs in checked luggage even

an increase correlating to that created by the hub connection. On the other hand, nonstop flights may take routes more direct than those taken by ground travelers, so that the distance traveled by air would be less than the distance traveled by land. *See, e.g.*, RICHARD B. MCKENZIE & JOHN T. WARNER, CENTER FOR THE STUDY OF AMERICAN BUSINESS, THE IMPACT OF AIRLINE DEREGULATION ON HIGHWAY SAFETY 7-8 (1987). If this is true, these estimates tend to understate the actual number of road fatalities.

70. *See* FEDERAL AVIATION ADMIN., CRIMINAL ACTS AGAINST CIVIL AVIATION 38 (1995).

71. *See* Fultz, *supra* note 22, at 64-65.

though the cabin, not the luggage compartment, has historically been the most common location for an explosive device.[72]

Given the paucity of information on benefits, the scenario developed below is based on the assumption that the threat from airline terrorism can be completely eliminated. Since 1982, 318 people have died in incidents of sabotage of U.S. carriers, an average of twenty-one people per year. Dividing this number into the cost estimate of a thirty-minute delay from the proposed security measures yields an annual cost per life saved of around $400 million.[73] To put this number into perspective, a review of studies suggests that a reasonable estimate for the implicit value of life for air travelers falls between $5 million and $15 million in 1995 dollars.[74] The FAA uses a value of $2.3 million per statistical life saved in evaluating its policies.[75]

If historical trends are indicative of future terrorist threats, the number of deaths prevented is likely to overstate substantially the benefits because the measures are not likely to be very effective in deterring terrorists. Nonetheless, I cannot rule out the scenario that terrorist activity could increase dramatically over my baseline estimates. But there would need to be a ten- to one-hundred-fold increase in the number of lives saved before this investment would look as attractive as other alternative methods of saving lives. Other life-saving investments that the Department of Transportation has required, such as side-impact standards for automobiles and cabin-fire protection in aircraft, have been over 400 times more cost-effective than this one.[76]

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72. *See* OSTER ET AL., *supra* note 8, at 160.

73. These estimates are based on the annual cost of $8.7 billion derived from using the FAA's value-of-time estimation. Assuming a delay of fifteen minutes would reduce the estimates by half. Likewise, assuming a value-of-time estimate half that of FAA's would reduce the estimates by half.

74. Kip Viscusi estimated the implicit value of life for air travelers based on the results of nineteen studies. The values ranged from $0.8 to $29.4 million per life in 1990 dollars. A majority of these estimates falls between $5 and $15 million when converted to 1995 dollars. *See* W. Kip Viscusi, *The Value of Risks to Life and Health*, 31 J. ECON. LIT. 1912, 1926-27 (1993).

75. FAA estimates the value of a statistical life to be $1.74 million in 1987 dollars. *See* FEDERAL AVIATION ADMIN., ECONOMIC VALUES, *supra* note 41, at ii.

76. The National Highway Safety Administration's 1990 automobile side-impact standards cost about $920,000 per life saved. The cabin fire protection requirement finalized in 1985 by the FAA had a cost effectiveness of $300,000 per life saved. Both numbers have been updated to 1995 dollars by the author, based on figures presented by John Morrall. *See* John F. Morrall, *A Review of the Record*, 10 REGULATION 25-34 (1986).

Moreover, the preceding estimates of the costs and benefits of security measures do not include the impact of increased automobile travel that would result from implementation of such measures. Based on the discussion of highway fatalities, an increase of 30 to 140 fatalities can be expected from a thirty-minute delay.[77] Unless the actual number of lives saved by the recommended antiterrorist measures is greater than the number of expected fatalities resulting from an increase in automobile travel, it is likely that there will be a net loss of lives per year in addition to billions of dollars of costs to consumers and taxpayers.[78]

Some may argue that even if the security measures are not very effective, people gain substantial benefits from the perception that the antiterrorist measures work. It may be that people are willing to pay large sums for the psychological benefit of feeling safer, but a strong argument can be made that absent concrete research supporting this assertion, the money required to implement these security measures would be far better spent by leaving it in the hands of consumers or having the government spend money on other antiterrorist or safety measures that would save more lives at a substantially lower cost.[79]

III. POLICY FLAWS

Even though the final result of the Commission's proposals is not yet known, it is evident that the proposals contain some important flaws. First, the recommended security measures are likely to have only a small impact on airline terrorism, precisely because they do not dramatically increase the cost of carrying out terrorist acts. Terrorists will find the weakest link in the

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77. *See infra* tbl.3.

78. In addition to causing deaths, the increase in traffic accidents will result in increased traffic injuries and the legal, medical, and property costs associated with such accidents.

79. For example, a study by Tammy Tengs and John Graham shows that by changing the current pattern of resource allocation to reduce risk, we could potentially save twice as many people at the same level of investment. *See* Tammy O. Tengs & John D. Graham, *Costs of Haphazard Investments in Life-Saving*, *in* RISK, COSTS, AND LIVES SAVED: GETTING BETTER RESULTS FROM REGULATION (Robert W. Hahn ed., 1996). Moreover, Kip Viscusi estimates that the income loss created from an expenditure of $50 million on efforts to reduce risk leads to a statistical death. *See* W. Kip Viscusi, *The Dangers of Unbounded Commitments to Regulate Risk*, *in id.*

chain in order to serve their purposes. If some U.S. airports and flights become less vulnerable, they will attack other targets, such as smaller airports. Raising the cost of terrorism is expensive because terrorists are difficult to apprehend and because the entire air system is not easily defended. The alternative would be to go after such groups more directly, but there are many limitations on what the state can do, due to constitutional protection of civil liberties.

Second, inattention to the costs and benefits of these recommendations will lead to some perverse outcomes because regulations can have unintended adverse consequences. As reported earlier, studies have found that proposals such as the requirement of child safety seats for infants on flights could cause a net increase in fatalities. The same perverse outcome is likely to result from a hasty implementation of proposed security measures. At the very least, the FAA should not implement programs that are likely to cause more deaths than they save. Unfortunately, some of the Commission's recommendations fall into this category.

Third, the primary beneficiaries of a service should pay for the usage of that service. Unfortunately, this principle appears to have been ignored in developing the recommendations for improving security.[80] The Commission calls for federal funding for these measures, arguing that aviation security is a national security issue.[81] But the primary beneficiaries of the antiterrorist measures would be air travelers. If this is true, then air travelers should be asked to pay the lion's share of the cost.

Only if these antiterrorist measures are really intended for other problems that benefit consumers at large should the public be asked to foot the bill. For example, enhanced screening technologies and profiling could reduce the flow of illegal drugs and contraband. If the proposed increase in regulations is really targeted at other activities, it should not be ushered in under the veil of increasing security against terrorism. Instead, the regulations should be evaluated on their own merits.

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80. The Commission, however, recommended establishing user fees to fund the air traffic control program.

81. *See* WHITE HOUSE COMM'N, FINAL REPORT, *supra* note 5, at 11.

IV. CONCLUSION

The government's overreaction to the TWA crash is both predictable and problematic. The Commission's proposals were based more on emotion than on reason. Fortunately, however, there is one reason to be optimistic: not much damage has been done yet. The recommendations give the FAA flexibility in developing regulations. If the regulations are developed judiciously, then some useful policy changes may be introduced. But such policy changes are unlikely to emerge unless we can learn from our regulatory successes and failures.

The Commission's response provides four general lessons. First, it is desirable to move beyond the rhetoric and examine the implications of a multibillion-dollar policy before foisting it on an unknowing and emotionally vulnerable public. Each step to reduce aviation fatalities has costs that can be measured in terms of direct expenditures, taxpayer costs, delay, inconvenience, restriction of civil liberties, and overall fatalities. Policies likely to lead to a net increase in fatalities, such as those examined above, should be avoided.

Second, risk-free air travel is not a realistic option because the cost—banning air travel—is simply too high. Even less drastic measures may be too costly to justify. In the case of preventing airline terrorism, a very sophisticated approach may not be desirable given its high cost. Israel has the most sophisticated security system in the world, but travelers must often spend three hours in the airport getting their baggage and themselves inspected.[82] Even if it were possible to transfer Israel's security system to the United States, a dubious proposition given the relative scale of airline operations in the two countries, the cost would be astronomical in terms of dollar expenditures, delay, and the increase in highway fatalities.

Third, because we cannot prevent all terrorist threats, we must decide on the costs we are willing to bear to achieve small reductions in this threat. We must also recognize that although some additional measures to reduce terrorism may be worthwhile, one quickly runs out of attractive options. For

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82. *See Aviation Security and Anti-Terrorism Efforts: Hearing Before the Subcomm. on Aviation of the House Comm. on Transp. and Infrastructure*, 105th Cong. 9 (1996) (statement of James C. DeLong, Aviation Director, Denver Int'l Airport) [hereinafter DeLong].

example, eliminating curbside baggage check-in probably makes sense if it reduces the likelihood that a terrorist can board a plane with explosives. Restricting access to secured areas and improving the training of security personnel make sense if they can be done at a reasonable cost. It also makes sense for federal agencies to share vital information about security threats with relevant airport and airline officials, provided the costs in terms of privacy are deemed acceptable. At the same time, deploying explosive detection technologies that are not extremely reliable is likely to lead to significant delays with little benefit in terms of enhanced security.

Fourth, politicians of all stripes have a strong tendency to overreact in the face of a crisis. Their overreaction is desirable to the extent that their rhetoric has a calming effect. But when their rhetoric yields hastily assembled policies, the results are often less than benign. Policy proposals offered in the heat of the moment, therefore, should be received with a healthy dose of skepticism. Moreover, there is an inherent political problem in asking a commission to address a particular issue when it is not given an explicit budget constraint in terms of society's resources. The natural tendency for such a commission is to select a host of options without attention to the economic burdens they will place on the average consumer. The Commission on Aviation Safety and Security was no exception.

Air safety and security concerns are likely to increase in the future. These concerns are too important to be addressed in an ad hoc manner. Economic analysis can help frame the policy discussion in addressing both of these concerns. Although it cannot replace judgment, economic analysis should be viewed as a critical aid to decision makers who are interested in separating rhetoric from effective policy.

V. APPENDIX

This appendix presents background information and a detailed explanation of the calculations in the Article. The first section summarizes the Clinton Administration's rapid response to the TWA disaster. The next two sections discuss the basis for the calculation of the delay costs and the adjustment of the cost estimates to account for a decrease in air travel. The following section calculates the potential effects on cost effectiveness that would result from implementation of the security measures proposed by the Commission. Finally, the effects of the policies on a traveler's transportation mode choice are considered.

A. *Overview of the Clinton Administration's Response to the TWA Crash*

Table 4 provides an overview of the response of the federal government to the TWA flight 800 crash. As noted in the Article, the Commission made recommendations, and Congress gave the FAA statutory authority and funding to implement many of the recommendations without much attention to implementation costs or possible delays.

B. *Airline Passenger Data*

Table 5 presents the relevant airline statistics for 1995 that were used in the calculations in the Article. The statistics cover all scheduled airline service for U.S. air carriers. Assuming that a passenger goes through security screening only at the originating airport, the number of security screenings is equivalent to the number of one-way trips taken per year.

The enplaned-passenger-mile figure overstates the number of one-way trips because this statistic double counts passengers with connecting flights. For example, if person X flies from city A to city B via city C, X is counted as two enplaned passengers although he took only one trip. Assuming that forty percent of passengers have a connecting flight and that a connector transfers once, the equation describing the relationship between enplaned passengers and number of trips is:

$$n_{enplanements} = 0.6\ (n_{trips}) + 0.4\ (2n_{trips})$$

where "$n_{enplanements}$" represents the number of enplanements and "n_{trips}" the number of trips.[83] Solving for the number of trips yields an estimate of 390 million one-way trips taken per year.

Forty-one percent of these trips in 1995 were taken for business purposes. The number was forty-seven percent in 1994.[84] In the calculations presented in this Article, the average

83. The figure of forty percent was estimated by economist David Swierenga. *See* Telephone Interview by Fumie Yokota, Research Assistant, American Enterprise Institute, with David Swierenga, Chief Economist, Air Transp. Ass'n (Sept. 12, 1996).

84. AIR TRANSP. ASS'N, *supra* note 36, at 11.

for the two years (44 percent) is used to estimate the proportion of trips that are taken by business travelers.

C. *Cost Adjustment*

The initial cost estimate must be adjusted to reflect the fact that fewer people will travel by air as the cost of air travel increases. The total decrease in air travel depends on the change in the cost of air travel and the elasticity of air travel.

The revenue per passenger mile (passenger revenue divided by passenger miles), which is $0.13 per mile, is used to estimate the price of air travel before the security changes. Adjusting the original cost of air travel to include the forty minutes of time each passenger spent at the airport before the new measures, the cost figure becomes $0.15 per mile if the FAA's value of time is used.[85]

The change in cost due to delays is the total delay cost divided by the total number of passenger miles. If the FAA's value of time is used, the change in price is $0.016. Using this figure yields a change in price of approximately eleven percent. Using other value-of-time estimates, reflected in Table 6, yields proportionate results.

For this calculation, an elasticity of 0.18 for business travelers and 0.38 for nonbusiness travelers is assumed.[86] This would reduce the original cost estimate from $8.7 billion to $8.4 billion, using the FAA's value-of-time estimate. This cost estimate does not include, however, the cost of switching for those passengers who shift modes. It also does not include lost profits or equipment and personnel costs incurred by airlines as a result of the new measures. For these reasons, the unadjusted costs are used in the following calculations.

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85. The forty-minutes figure is based on an estimate of airport dwell time given by James DeLong, chairman of the Airport Council International - North America, in written testimony to the House Committee on Transportation. *See* DeLong, *supra* note 82, at 9.

86. *See* MORRISON & WINSTON, ECONOMIC EFFECTS, *supra* note 56, at 17. See the "Mode Shift" section of this Appendix for a discussion of the elasticity estimates.

D. *Cost Effectiveness*

The cost effectiveness of a policy is determined by the costs incurred per life saved.[87] Considering the doubtful effectiveness of the new security measures, to use the best-case scenario would be to assume that the lives saved from these security measures is equal to the average number of sabotage deaths in recent years.

The National Transportation Safety Board compiles data on U.S. airline accidents and acts of sabotage. There have been 318 fatalities resulting from sabotage of U.S. airlines between 1982 and 1996, an average of twenty-one fatalities per year.[88]

Using these estimates, $8.7 billion in delay costs (the FAA's cost estimate in 1995 dollars, based on a thirty-minute delay) translates to a cost per life saved of $410 million. The Case A estimates noted in Table 2 would yield $370 million per life saved; Case C would yield $460 million per life saved; and Case D would yield $200 million per life saved. The estimates would be half as large if the additional delay were fifteen minutes, or twice as large if the additional delay resulting from the implementation of security measures were one hour.

E. *Mode Shift*

To determine the increase in the number of people who die in traffic accidents, the number of people who shift from air travel to road travel must be calculated. Although the cost figures mentioned above were based on inconvenience to all travelers, the calculation of the shift to road travel focuses on domestic passengers. The reason for this focus is that automobile travel is not a viable alternative for most international flights. Also, the elasticity estimates used in our calculations are based on domestic travel data. The domestic delay cost estimate derived from the Air Transport Association's statistics regarding total annual domestic airline travel (Table 5), the FAA's value of time, and a thirty minute delay is $8.0 billion. This estimate is used in the following calculations. The change in cost from a thirty-minute delay is calculated to be approximately fourteen percent greater than the original cost

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87. A more precise measure would be the cost per life-years saved. Using this measure would not change the basic policy conclusions developed in this Article.

88. *See* NATIONAL TRANSP. SAFETY BD., DEATHS RISE, *supra* note 7, at tbl.6 (1997).

for domestic travel, using the methods outlined in the above cost-adjustment discussion.

The figures used below for modal-share elasticities for business and nonbusiness air travel are estimates made by Morrison and Winston from an intercity passenger transportation demand model.[89] These calculations are based on the assumption that the size of the market is held constant.[90] The change in modal share of air is assumed to shift completely to automobile travel, because ninety-eight percent of ground travelers on long trips travel by automobile (only two percent travel by bus or train).[91]

Assuming that business travelers account for forty-four percent of air travel, there are 173 billion passenger miles of domestic business trips annually. Applying the business travelers' elasticity of 0.18 to the percentage change in domestic air travel cost shows the percentage of air travelers that will shift to road travel. Multiplying this figure by the total number of business travel miles yields a decrease of 4.3 billion passenger miles traveled by plane. Passenger miles are then converted to vehicle miles, because fatality rates for traffic accidents are given in vehicle miles. Dividing the number of passenger miles by 1.55 occupants per vehicle converts the estimate to vehicle miles. The same procedure is repeated, using an elasticity of 0.38 and an occupants-per-vehicle figure of 2.35, to obtain the vehicle-mile increase for nonbusiness travelers. (These calculations are outlined in more detail in Table 7.) This yields a total annual increase of 7.6 billion vehicle miles.[92] Assuming a fifteen-minute delay would decrease the total vehicle miles by half; assuming a sixty-minute delay would double the estimate.[93]

89. *See* MORRISON & WINSTON, ECONOMIC EFFECTS, *supra* note 56, at 17.

90. *See id.* at note 16.

91. *See* FEDERAL HIGHWAY ADMIN., 2 NATIONWIDE PERSONAL TRANSPORTATION SURVEY: 1990 NPTS DATABOOK 8-20 (1994). Long trips are defined as trips over 75 miles one way.

92. The FAA created a panel to discuss the appropriate elasticity measure to use in its child-safety seat study. *See* FEDERAL AVIATION ADMIN., U.S. DEP'T OF TRANSP., 2 REPORT TO CONGRESS: CHILD RESTRAINT SYSTEMS B-8 (1995). The FAA report noted that Morrison and Winston's estimates are much lower than other estimates. Because the Morrison and Winston estimates were based on pre-deregulation data, the report conjectured that the air passengers may have displayed less price-sensitive behavior during that period because of the limited choices in fares. *See id.* at G-6. If this is true, the above estimates may understate the magnitude of actual mode shift.

93. The total vehicle miles is linearly dependent on the delay time assumption.

The preceding calculations use the base case elasticity of 0.18 for business travelers and 0.38 for nonbusiness travelers. A high scenario and a low scenario are estimated using elasticities of 0.1 and 0.2 for the low case, and 0.5 and 0.7 for the high case. This yields an increase in vehicle miles of 4.1 billion for the low case and 16.7 billion for the high case.

The FAA used a slightly different approach to calculate mode shift in its study on the impact of requiring child restraint systems for infants under two years of age. It used an estimate of a general price elasticity, rather than a modal-share elasticity, to determine the total decrease in the number of trips by families with infants. It then distributed the change into three categories: (1) those who did not travel at all; (2) those who traveled by passenger cars; and (3) those who traveled by other ground transportation (namely trains and buses). Using this approach, with elasticity estimates of 1.15 for business travelers and 1.52 for nonbusiness travelers,[94] yields an increase in 12.7 billion vehicle miles. This value is within the range calculated in this Article but is about double the base case estimate.

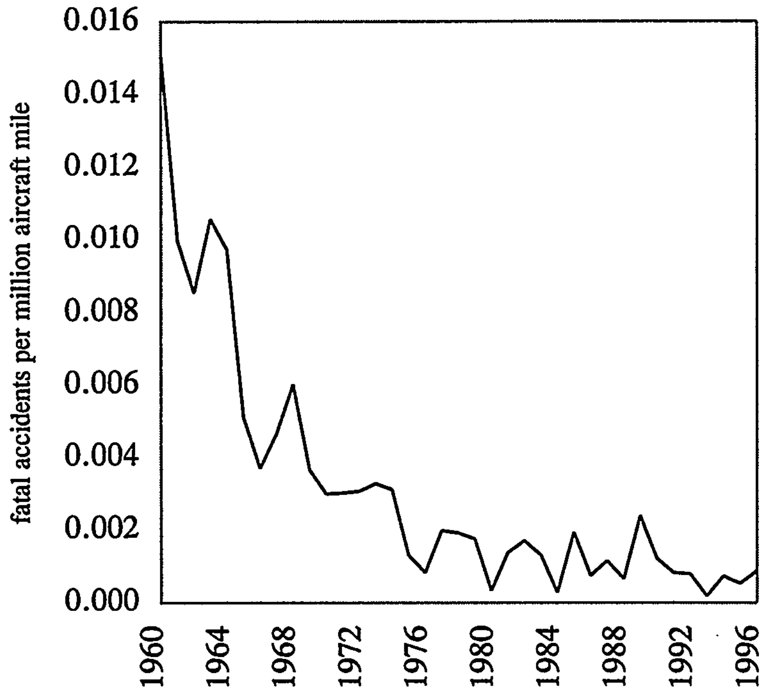
Another approach is to use the change in travel time and a travel-time elasticity rather than cost elasticity to estimate the shift to road travel.[95] Using a travel-time elasticity of 0.16 for business and 0.43 for nonbusiness[96] yields an increase of 10.3 billion vehicle miles. This is also within the range calculated in this Article.

94. *See* Tae Hoon Oum et al., *Concepts of Price Elasticities of Transportation Demand and Recent Empirical Estimates*, 16 J. TRANSP. ECON. & POL'Y 149 tbl.3 (1992).

95. One problem with using this approach is that travelers may value different portions of the air travel differently. For example, increasing flight time may have very different effects on mode choice than similarly increasing waiting time at the airport.

96. *See* MORRISON & WINSTON, ECONOMIC EFFECTS, *supra* note 56, at 17.

FIGURE 1: FATAL ACCIDENTS ON U.S. AIRLINES OPERATING UNDER 14 C.F.R. 121 (SCHEDULED AND NONSCHEDULED SERVICE)



This figure is based on data compiled by the National Transportation Safety Board and the Bureau of Transportation Statistics. *See* BUREAU OF TRANSP. STATISTICS, *Historical Compendium, 1960-1992, in* NATIONAL TRANSPORTATION STATISTICS ANN. REP. (1993) (data for years 1960 through 1981); NATIONAL TRANSP. SAFETY BD., DEATHS RISE, *supra* note 7, at tbl.5 (data for years 1982 through 1996).

TABLE 1: RECOMMENDATIONS FROM THE COMMISSION'S INITIAL REPORT

	Recommendations	Budget Request for FY 1997	Projected Cost	Implementation Status
1.	Consortia to implement changes.	None	NA	Forty-one major airport consortia have submitted plans for FAA review.
2.	Conduct airport vulnerability assessments.	$5.5 million	NA	Consortia are conducting assessments and addressing problems.
3.	Require criminal background checks.	None	NA	The FBI has reduced fingerprint-check turn-around time to at most seven days.
4.	Deploy existing technology.	$161.3 million	$0.4 to $2.2 billion in startup costs, 10% annually for CTX 5000. $1.9 billion to provide 3,000 passenger screening devices.	The FAA has ordered 54 advanced explosives detection systems.

TABLE 1, CONT'D: RECOMMENDATIONS FROM THE COMMISSION'S INITIAL REPORT

	Recommend-ations	Budget Request for FY 1997	Projected Cost	Implementation Status
5.	Establish a joint government-industry research-and-development program.	$20 million	NA	The FAA is working with industry to develop agreements and award research grants.
6.	Significantly expand the use of bomb-sniffing dogs (114 additional teams recommend-ed).	$8.9 million	$8.8 million	The FAA received funding for 114 new dog teams, and training has begun.
7.	Assess the viability of an antimissile defense system.	None	NA	DOD will convene an interagency task force to examine the threat to civil aircraft.
8.	Complement technologies with automated passenger profiling.	$10 million	NA	Profiling systems are being developed.
9.	Certify screening companies and improve screener performance.	$5.3 million	NA	The FAA has begun rulemaking procedures to require new certifications.
10.	Aggressively test existing security systems.	$18 million	NA	The FAA is hiring 300 new special agents to test airport security.

TABLE 1, CONT'D: RECOMMENDATIONS FROM THE COMMISSION'S INITIAL REPORT

	Recommend-ations	Budget Request for FY 1997	Projected Cost	Implementation Status
11.	Use the U.S. Customs Service to enhance security.	$26.6 million	NA	The Customs Service is deploying 140 inspectors and investigators at critical airports.
12.	Give key airline and airport personnel access to classified information.	None	NA	The FAA is arranging for adequate clearance levels at airports and airlines.
13.	Begin implementing full passenger-bag match.	None	$2 billion in startup and lost revenue costs	The FAA and airlines are testing passenger-bag match options.
14.	Give the NTSB primary responsibility for providing services for families of crash victims.	None	NA	The NTSB was given the role of coordinating accident response.
15.	Improve passenger manifests.	None	NA	
16.	Increase the number of FBI agents assigned to counter-terrorism investigations.	$146.6 million	NA	The FBI is adding 644 agents and 620 support personnel for counter-terrorism efforts.

TABLE 1, CONT'D: RECOMMENDATIONS FROM THE COMMISSION'S INITIAL REPORT

	Recommendations	Budget Request for FY 1997	Projected Cost	Implementation Status
17.	Implement airport security training abroad.	$2 million	NA	The State Department and the FAA are sponsoring domestic and foreign courses.
18.	Research the effectiveness of explosives taggants.	$21.3 million	NA	Studies by the Bureau of Alcohol, Tobacco, and Firearms (ATF) have been initiated, with results to be implemented in 1997.
19.	Implement explosive-detection training for law-enforcement personnel.	$1.8 million	NA	The ATF and FAA will deliver a training course for airport law enforcement agencies.
20.	Create a central clearing house for information about crimes involving explosives.	$2.1 million	NA	The Secretary of the Treasury has established a national repository of such information at the ATF.

For information regarding recommendations, budget requests, and implementation status, see generally WHITE HOUSE COMM'N, FINAL REPORT, *supra* note 5; WHITE HOUSE COMM'N ON AVIATION SAFETY AND SECURITY, INITIAL REPORT TO PRESIDENT CLINTON (1996). For information regarding projected costs, see generally Fultz, *supra* note 22; *Terrorism and Drug Trafficking*, *supra* note 25; GENERAL ACCOUNTING OFFICE, BRIEFING REPORT TO CONGRESSIONAL REQUESTERS: TERRORISM AND DRUG TRAFFICKING: THREATS AND ROLES OF EXPLOSIVES AND NARCOTICS DETECTION TECHNOLOGY (1996); Tomlinson, *supra* note 27.

TABLE 2: COST OF DELAY IN 1995 DOLLARS

	Value of time (per hour)			Annual Cost (in billions)		
	Source	Business Travel	Non-Business Travel	Fifteen-Minute Delay	Thirty-Minute Delay	Sixty-Minute Delay
Case A	Brand (1996)	$55	$29	$4.0	$7.9	$15.8
Case B	FAA (1989)	$48	$42	$4.4	$8.7	$17.4
Case C	Morrison and Winston (1989)	$50	$50	$4.9	$9.8	$19.5
Case D	Half of FAA	$24	$21	$2.2	$4.4	$8.7

TABLE 3: ANNUAL INCREASE IN FATALITIES (BASED ON A THIRTY-MINUTE DELAY)

	Elasticity		
	Low	Base	High
FAA	34	63	139
Half of FAA	19	34	76

TABLE 4: RESPONSE TO THE TWA 800 CRASH

July 17, 1996	TWA flight 800 crashes off the coast of Long Island en route to Paris from New York.
July 25, 1996	President Clinton creates the White House Commission on Aviation Security and Safety (the Commission), headed by Vice President Gore, and the FAA announces increased security levels at U.S. airports.
September 9, 1996	The Commission submits an initial report to the President. President Clinton proposes a $430 million budget amendment for 1997 to implement the initial recommendations of the Commission.
September 30, 1996	President Clinton signs two appropriations bills providing funding for most of the Commission's recommendations.
October 9, 1996	President Clinton signs into law most of the Commission's recommendations through the Federal Aviation Administration Reauthorization Act.
January 13-15, 1997	The Commission and George Washington University sponsor the "International Conference on Aviation Safety and Security in the 21st Century."
February 12, 1997	The Commission releases its Final Report, which includes 57 recommendations.

TABLE 5: U.S. CARRIER SCHEDULED SERVICE 1995
(IN 1995 DOLLARS)

	Domestic	International	Total
Enplaned passengers (in millions)	499	49	547
Revenue passenger miles (in billions)	394	146	540
Passenger revenue (in billions)	$53	$16	$69
Average haul (miles)	791	2,992	987

SOURCE: Air Transp. Ass'n, 1996 Annual Report (1996).

TABLE 6: CHANGE IN COST AND DECREASE IN AIR TRAVEL (IN 1995 DOLLARS)

	Case A	Case B	Case C	Case D
Value-of-time estimates	Brand (1996)	FAA (1989)	Morrison & Winston (1989)	Half of FAA
Original cost per passenger mile	$0.147	$0.149	$0.152	$0.139
Delay cost (in billions)	$7.9	$8.7	$9.8	$4.4
Delay cost per passenger mile	$0.015	$0.016	$0.018	$0.008
Percentage increase in cost	9.9%	10.8%	11.9%	5.8%
Percentage decrease in air travel	2.9%	3.2%	3.5%	1.7%
Adjusted delay cost (in billions)	$7.7	$8.4	$9.5	$4.3

TABLE 7: SHIFT TO ROAD TRAVEL
(BASED ON A THIRTY-MINUTE DELAY)

	Business	Nonbusiness
Proportion of air travel	44%	56%
Passenger miles of air travel (domestic) (in billions)	173	221
Elasticity	0.18	0.38
Percentage change in share	2.5%	5.2%
Decrease in passenger miles of air travel (domestic) (in billions)	4.3	11.4
Occupancy per vehicle	1.55	2.35
Increase in vehicle miles of road travel (in billions)	2.8	4.9