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**THE ECONOMIC IMPLICATIONS OF
TERRORIST ATTACK ON COMMERCIAL
AVIATION IN THE USA**

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Executive Summary

The air transportation system is an attractive target for terrorists. Using widely available weapons, terrorists could shoot down a passenger airliner. This disruption would be magnified if the attack caused terror in the general population and led government officials, the media, and the public to engage in costly preventive actions. Although various defenses could be mounted against attacks by missiles, rocket propelled grenades, and high powered rifles, no countermeasure could protect against all of them or even be completely successful against MANPADS.

The immediate effect of shooting down an airliner would be hundreds of deaths and a cost to the airline of about \$1 billion for the aircraft and payments to the survivors of deceased passengers, as well as reduced demand for all air services. Reduction in demand for air services depends on how the government, the media and the general public react to the attack. An unsuccessful attack could generate similar reaction from the public resulting in similar losses in transportation and related business. Closing an airport for more than a few days would throw thousands of people out of work and generate losses to the surrounding businesses and those who depend on the airport and air transport of freight. Closing US airspace immediately after the attack would cause diversion of flights, stranded passengers, and major costs to the airlines and travelers.

There are two major components to the economic cost of a successful terrorist attack. The direct cost for the downed aircraft and lives lost would be about \$1 billion per aircraft. The indirect cost would result from operating losses to the airlines and loss of consumer welfare as some people would not fly. These amounts would depend on the length of any interruption in air travel and the public's long term reaction to terrorist threat to flying. The indirect economic cost would be greater than the direct cost and would depend on how the government reacts (investing in countermeasures and/or closing airports) and how the public reacts (measured in reduction in travel demand). While the cost of countermeasures and airport closures can be estimated, the main determinant of long term costs, the reaction of the public, is unpredictable.

If a terrorist managed to shoot down a large passenger aircraft and this resulted in grounding all aircraft for 2.5 days (as was the case after 9/11), the loss to the economy would be \$1 billion per air craft (including compensation for the dead passengers) (RAND), \$1.6 billion in reduced airline and associated spending, and \$4.75 billion in losses to business and leisure passengers. The total cost of \$6.3 billion per 2.5 days (or \$2.5 billion per day) makes a ground attack against commercial aircraft a tempting target. There are few areas in the USA where a lone terrorist with readily available weapons could inflict such a high cost on the economy, and possibly cause widespread terror.

We classify the long-term response to a terrorist attack on an airliner into three general scenarios. First, even a successful attack could be regarded as one of the unfortunate aspects of living in the 21st century. Some additional protection would be provided to airports, but air transportation would go on as before. Second, airports and airliners could be given the best available protection against attacks. This second scenario would

cover a range of possible defenses. All would include anti-missile defense systems on airliners. In addition, protection against rocket propelled grenades (RPG) and large caliber (LC) rifles would range from improved patrols and security around airports to keeping people far enough away from the airport to keep them out of range. The latter would be impossible for some airports (Chicago Midway) and extremely expensive for others. One example where something like this has been done is that a community adjoining LAX was purchased by the airport and evacuated. However, while these defense measures may serve as deterrent, there is not one sure way of protecting all aircraft from all weapon systems. Therefore, successful attack would still be possible. In the third scenario, all non-military aviation could be suspended for a period ranging from days to years.

The first scenario would be least costly, unless the terror attacks managed to bring down more than a few (large aircraft each year. At \$1 billion per successful attack, the direct dollar costs would be less than the other two alternatives, assuming that the commercial aviation would operate normally with the same load factors, despite the terror attacks..

The second scenario involves equipping all commercial airliners with a laser-jammer system to deter missiles. The ten-year life-cycle cost for developing, installing, operating and supporting laser-jammer countermeasures are estimated to be \$40 billion (RAND). This system would be effective against some, but not all shoulder fired missiles, and would not help against RPGs or LC rifles. To guard against the latter, airport security and patrols could be strengthened or, in the extreme, airport perimeters could be extended at least one-mile so that a terrorist at the fence would be at least 1-2 miles away aircraft taking off, landing or taxiing. Flight path would be restricted and flights would be scheduled for daylight hours only. Airports embedded in urban areas would be the hardest to protect. Private vehicles would be barred from the airport. These airport restrictions are likely to be more expensive than equipping all aircraft with countermeasures.

The third scenario, ending commercial aviation temporarily, is estimated to cost \$2.5 billion per day in lost revenue to airlines and their suppliers and losses to passengers as estimated by consumer surplus. In addition, the regional economy around each airport would suffer from lack of business and not being able to ship cargo in or out. Shut down of US exports and imports by air would add to mounting costs. The national economy would suffer a slower growth rate and reduced productivity from not having air transportation available.

If it were possible, the most valuable DHS program would be one that prevented all attacks. That is impossible. If it were possible, the next most attractive program would be one that protected all aircraft in case of an attack. That is impossible; partial protection is possible. The most costly option would be grounding all commercial flights. While these are significant costs, if the public loses confidence in flying and few people are willing to fly, the airline losses and costs to the economy would be higher than the other three programs.

We conclude that the US Government should (1) do what it can to prevent terrorist attacks on aircraft and (2) more importantly develop a campaign to prevent widespread panic if an attack occurs. We think it likely that terrorists will target aircraft and that they will mount a visible attack, possibly succeeding in downing an aircraft. The vast majority of the resulting cost to the economy would be avoided if the public does not panic and if the government does not require costly actions designed to reassure the public, but which have little efficacy in preventing further loss. This program requires warning the public about the possibility of an attack and translating the reaction following an attack into a rational, rather than panic response. One goal would be to get the public officials, the media, and the public to understand that attacks against airlines cannot be prevented, that closing US airspace is not a reasonable policy, and that countermeasures at the airports or on aircraft should be evaluated for effectiveness and cost-effectiveness before they are implemented.

We recommend that the DHS and FAA study and develop protocols to address three issues: (1) Should a terrorist attack close a single airport, airports in a region, or all airports in the nation? (2) Should closure be for a day, a week or longer? (3) Under what conditions should airports be reopened? Other issues to be studied include what to tell passengers, flight crews, and airport employees following an attack, how to balance the immediate need to find the attackers with the disruption that closure and search would cause, and how to balance the need for security with inconvenience to employees, passengers, and people living near the airports.

PURPOSE OF THIS STUDY

The purpose of this study is to evaluate the economic implications of a terrorist attack on commercial aviation in the United States. The most important factor determining the economic cost of an attack is how the government, media, and public react to an attempted or successful attack. If the attack caused terror, that is, irrational, fearful responses, the economic costs could be extremely high, especially if the terrorists were able to launch several successful attacks. Even if an aircraft were destroyed every year, if the government and public perceived current policies to be justified and regarded the loss of life as bearable, as occurred in the UK with the IRA attacks, the costs would be much lower.

An attack that caused many deaths and injuries need not cause terror, just as an attack that did not cause deaths or injuries could induce terror. For example, more than 40,000 people in the USA die and 3 million are injured in highway crashes each year. Despite the large number of deaths, there is no terror. People simply regard highway crashes as an unfortunately part of having motor vehicles. At the other extreme, the core melt at Three Mile Island caused panic and terror, even though no one was killed or injured severely. People were apprehensive about nuclear power and the incident seemed to confirm their worst fears and provoke panic. We stress that government could take steps to lessen the impact and panic that would result from terrorists shooting down a commercial airliner.

Our approach in this study is to construct three scenarios concerning reactions to attacks against commercial aircraft. We assume that the national reaction and economic consequences will not depend on whether the aircraft is brought down by a MANPAD, rocket propelled grenade (RPG), or large caliber (LC) rifle, as long as the terrorist action is recognized as an attack. If an attack by an LC rifle were unsuccessful, it might not be noticed and so would not lead to behavior changes. An unsuccessful attack by a MANPAD or RPG would be noticed.

If aircraft are equipped with countermeasures, a successful attack might have an even stronger reaction than if there were no countermeasures. The public might conclude that we cannot defend against these attacks. If the countermeasures were successful, the public generally might conclude that it will be safe to fly because the countermeasures are effective. We emphasize that the key to the economic costs is the reaction of government, media, and the public. An attack that caused terror could be extremely costly. At this point, we have no confidence that we or others could predict public response to an attack on civil aircraft.

We divide the costs to those accrued immediately after the attack (such as loss to airline attacked), longer term microeconomic and sector specific costs (such as the loss to the airlines over months and years) and the cost of suspending commercial aviation to the US economy.

Economic Costs

We analyze the costs in depth later in the report; here we focus on the three largest costs: The cost to the airline of the downed aircraft, the loss revenues to airlines and their suppliers if all flights were grounded, and the loss to business and leisure travelers if they could not fly.

The Cost of a Downed Aircraft: If a large passenger aircraft were shot down, the cost would be about \$1 billion (RAND). Replacing the aircraft would cost \$200-250 million. If 300 passengers died, the settlements would be about \$2-2.5 million per each premature death (RAND).

The Cost of Lost Sales: If air travel were restricted, the U.S. input-output table can be used to estimate the losses to businesses that supply goods and services to the industry. For example, decreasing air transportation by \$1 million (holding load factors constant) would diminish the purchases of petroleum refining services by \$110,000. The first column of **Table 1** shows the top 12 sectors that supply the air transportation sector. The second column shows the amount each sector would lose (in millions of dollars) if air transportation expenditures were cut by \$1 million. The third column shows the effect on all the industries if air transportation were closed for a day, resulting in a revenue loss of \$320 million (the 2003 gross receipts of the air transportation sector were \$116.8 billion, which is \$320 million of revenue per day). The table indicates that grounding airlines for a day would lead them to buy \$36 million less petroleum refining, and reduce total spending in the economy by \$637 million; grounding all aircraft for 2.5 days would reduce total spending by \$1.6 billion. The analysis indicates that eliminating all air transportation service would impose a huge penalty on the US economy in terms of reductions in spending.

Table 1. Estimated losses to sectors that supply goods and service to air transportation

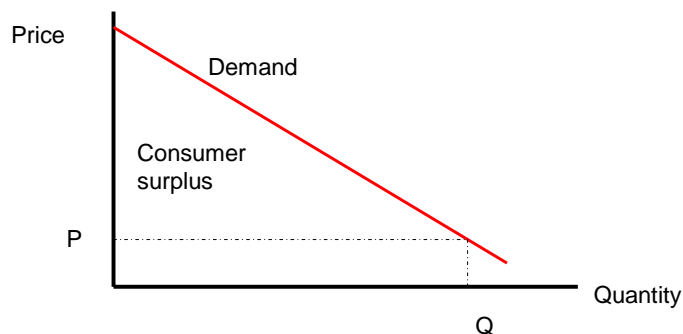
Sectors	Total purchases from other sectors (\$ in millions)	
	\$1 million loss in air transportation per day	\$320 million loss in air transportation per day
Air transportation	1.06	341
Petroleum refining	0.11	36
Noncomparable imports	0.10	32
Crude petroleum and natural gas	0.081	26
Arrangement of passenger transportation	0.07	24
Computer and data processing services	0.04	114
Wholesale trade	0.03	16
Real estate agents, managers, operators, and lessors	0.039	11
Advertising	0.02	8
Telephone, telegraph communications, and communications services n.e.c.	0.02	8
Eating and drinking places	0.02	7
Legal services	0.02	7
Aircraft and missile engines and engine parts	0.02	6

The Loss to Business and Leisure Passengers: Economists estimate the total cost to consumers of a change in the price or availability of a product or service by estimating the change in “consumer surplus.” Most people buying a product would be willing to pay more than the price. As illustrated in Figure 1, the demand schedule measures how much people would be willing to pay for a specified quantity of the good. For the quantity Q in the figure, the market clearing price would be P . However, since almost everyone buying the good would be willing to pay much more, the total benefit of selling quantity Q at price P is the area under the demand schedule above the current price. For example, if no water were available, people would be willing to pay a great deal for the first pint of water. At present, water costs perhaps 0.2 cents per gallon. At this price, we use a great deal of water, letting the water run to cool off and constructing golf courses in the desert. Some people would be willing to pay one-million times the current price for the first pint of water.

Figure 1

Consumer Surplus Estimate

The triangle between the demand curve and the current price measures the “surplus” value that consumers get



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According to the Department of Transportation, the average price of flying is about 11 cents per revenue passenger mile. In 2003, the domestic airline industry delivered 660 Billion revenue passenger miles.

Some have much higher prices for a regular coach ticket. For example, the standard fare for a Pittsburgh-Washington, DC flight is \$2.20 per mile (about \$880 for a round trip for a 7-day advance purchase). Many people pay this fare at present. This is undoubtedly not the highest price that people would be willing to pay for air service, but we assume that it is. Consumer surplus is calculated as the area under the demand curve above the current price. Assuming that demand is a linear function, the area in the triangle is one-half the base times the height or $0.5(2.20 - 0.11)660$ billion = \$686 billion per year. Dividing this figure by 365 days per year, the consumer surplus from commercial air travel is \$1.9 billion per day. Thus, we estimate that the 2.5 day suspension of air service after 9-11 cost the nation \$4.75 billion.

To improve the estimate of consumer surplus, we need to know the maximum price that people would be willing to pay for the first flight when there was no air service, and then the amount that people would want to fly (RPM) for each price level. For example, if no one were willing to fly at a price of \$20 per passenger-mile, but someone would be willing to fly for \$19.99 per PM, that would be the first point on the demand curve. We would then need to know how many RPM would be purchased at \$19.98/PM, \$19.97, etc. down to \$0.10. The area under this demand curve would be the consumer surplus. It would estimate the loss to those who fly of losing air service; the information could also be used to estimate the loss if restrictions on air travel boosted the fares from the current \$0.11/PM level. Our judgment is that the true consumer surplus is larger than our \$1.9 billion per day estimate.

Since the survey would include both business and general travel, it would measure the loss of higher than current prices of air travel to both types of passengers. Since companies have private aircraft for their executives, they show that they are willing to pay a great deal for some air travel. The consumer surplus measure would encompass the loss to all those who fly.

Thus, the consumer surplus estimates the loss to travelers of restrictions on air travel and the input-output analysis estimates the lost revenue to airlines and their suppliers from restrictions on air travel. Together, they indicate the importance of the airline industry, one reason why it is an attractive target to terrorists, and the cost of restrictions on air service that raised price or decreased passenger demand.

Thus, if a terrorist managed to shot down a large passenger aircraft and this resulted in grounding all aircraft for 2.5 days, the loss to the economy would be \$1 billion per air craft, \$1.6 billion in reduced spending, and \$4.75 billion is losses to business and leisure passengers. The total cost of \$2.5 billion per day makes a ground attack against commercial aircraft a tempting target.

WEAPONS

This report explores the cost of potential terrorist attack from the ground on commercial aircraft in the air. There are several external weapons systems that could be used successfully to damage or destroy aircraft in the air or on the ground (O’Sullivan 2004):

1. “Man-portable air defense system” (MANPAD), which are light, transportable surface-to-air anti-aircraft missiles (SAMs). They could be guided by:
 - infrared,
 - laser beam rider,
 - command line-of-sight
2. Combat weapons:
 - automatic assault weapons
 - high-caliber rifles
 - machine guns
3. Ground-to-ground ballistic weapons:
 - rocket-propelled anti-armor and -personnel weapons (RPGs)
 - mortars
4. Future weapons:
 - Lasers
 - high-energy Explosives

All of these systems are portable and relatively easily available. They differ in their effective range. PRGs could be used to attack aircrafts on the ground or close to the ground, while MANPADS are effective at attacking in the air. Large caliber rifles have a range up to two miles and could be used at the fence at many airports. These weapons could be used to attack a commercial aircraft from outside of the airport perimeter. Terrorist who would use them need not go through airport screening to get within range. These weapon systems could attack aircrafts not only in the air, but also on the ground, during taxiing, or at the terminal. In addition, some of these weapons could be used to damage airport infrastructures.

O’Sullivan describes these weapon systems, how they could be used against civilian aircraft both on the ground and in the air, their effective range, the history of attacks by these weapons against civilian aircraft, their countermeasures and the potential costs and benefits of these countermeasures. O’Sullivan concludes that “at some point in the near to long term future, it seems inevitable that MANPADS or other weapons will be smuggled into

the United States, or acquired internally, and used in a domestic terrorist attack against civilian aircraft. There are simply too many cheap and comparatively easy methods available to attack, cause casualties, and damage and even destroy aircraft in the air and on the ground.” Unfortunately, O’Sullivan concludes that “total prevention is impossible”.

A report by the RAND Corporation¹ supports this conclusion by stating that a multilayered approach to defend against these weapon systems is needed “because no single countermeasure technology can defeat all possible MANPADS attacks with high confidence.” As new countermeasure technology is invented, new attack technologies would be developed. It is likely to be cheaper and faster to build new attack devices than to fit all commercial aircraft with new countermeasures. At the same time, countermeasures may deter some terrorist, thus make attacks less likely.

No one knows how the public would react to an attack against commercial aircraft in the USA. In the absence of an attack, deploying an anti-missile systems or other countermeasure might either reassure the public or make them more apprehensive. If an attack occurred, successful or unsuccessful, no one knows how installation of a partially protective countermeasure would affect public confidence in flying. Therefore, in this report we will not discuss the effect of countermeasures systems on travel behavior.

Commercial air service is an attractive target for terrorists. Air crashes are highly visible, the area around airports is accessible to terrorists, and weapons are readily available that could bring down an aircraft causing the deaths of hundreds of people. At present, there is no reliable defense. A successful attack might cause terror in the public and result in irrational actions by the government and the public.

THE ATTACK

In this study we examine the consequences of a terrorist attack on a commercial passenger jetliner from the ground shortly after take off when the plane is fully loaded with fuel or shortly before landing. An attack at takeoff would cause more damage because of the additional fuel onboard. Since the terrorists are not onboard the plane, it could not be hijacked and so could not be aimed at another target, as in 9-11. However, the crash could result in damage to buildings and injury to people in the area. Which airline owns the plane is not important. To maximize terror, the terrorist is assumed to choose a wide body plane (e.g., a B747) at one of the busiest US airports, at peak travel time during a peak travel period, such as the Sunday after Thanksgiving.

¹ *Protecting Commercial Aviation Against the Shoulder-Fired Missile Threat*, James Chow, et al. **The RAND Corporation** 2005

An aircraft hit by a bullet, RPG, or missile might be able to land safely, although the effect on public anxiety might not be very different.

The easiest attack for terrorists to mount would be a single terrorist attacking one aircraft with a MANPAD, RPG, or LC rifle. A terrorist with several missiles, RPGs, or bullets might be able to down more than one plane before countermeasures could be taken. Even for the shortest-range weapon, a terrorist would have a good chance to escape after firing. Thus, one terrorist might be able to down one or more fully loaded B747 without being apprehended.

9-11 demonstrated that terrorists are capable of mounting coordinated attacks in different locations with more than a dozen men. A coordinated attack might involve several terrorists at the same airport or, more effectively, simultaneous attacks at several airports. Terrorists in different locations could use cell phones to coordinate their attack.

In analogy to a serial killer, such as the Washington sniper, a single terrorist could attack several airports over time, hitting airports when normal operations had resumed. As in the Washington sniper case, this form of attack is likely to cause widespread terror. A coordinated attack on several airports in different times would do more terror to shake the public's confidence in flying.

We summarize by noting that a reported attack could result in:

- A false alarm (no actual attack)
- No damage: an unsuccessful attack (for example a missile is fired but misses the aircraft, such as the attack on an El Al aircraft in Kenya)
- A successful attack with emergency landing that everyone survives (such as the DHL plane in Baghdad)
- A successful attack with no survivors
 - A single or multiple attacks at one location at one time
 - A series of attacks over time and in different places

REACTION TO THE ATTACK

Since there has not been such an attack in the USA on a commercial aircraft, there is no firm background from which to extrapolate. The two closest types of events that happened on US soil are (1) 9-11, in which four commercial aircraft were hijacked and three were used as missiles to destroy buildings, and (2) crashes of commercial aircraft due to pilot error, equipment malfunctions, or other errors. Unfortunately, these events may not be regarded by civil aviation authorities, airlines, or the public as close analogies to an attack from the ground on a commercial airliner.

Immediate Reaction

We assume that a missile or RPG fired at a commercial aircraft would be detected immediately and unequivocally, even if the missile did not hit its target. An LC rifle attack might not be detected immediately, if it failed to bring down the plane; it might never be detected if the bullet missed the plane. Any airline crash is likely to be regarded as a possible terrorist attack, until proven otherwise.

Attacked Airport's Reaction

The immediate reaction at the airport where the attack happened would be to close the airport, move aircraft out of range of the attackers, emptying runways and taxiways, evacuating ground facilities and evacuating airport personnel. Planes still on the ground would return to their gates to unload passengers. Aircraft in the air would be diverted to other airports, if possible (aircraft are required to have sufficient fuel to be diverted to a primary or secondary alternate airport). As occurred on 9-11, we assume that all aircraft would be ordered to land at the closest airport not attacked.

Flights get diverted to other airports, on average 20 times per day in the US, because of flight delays, weather, etc. These are unanticipated diversions. If a flight were expected to be diverted, an airline would not let the flight take off, since diversion is expensive and it would be cheaper to delay or even cancel the flight. If the destination airport is expected to be closed, the airline and the FAA would hold the flight until the airport reopened.

When a flight is diverted, the passengers need to be taken to the scheduled airport. That requires air or ground transportation, long delays and makes passengers unhappy.

Diverting a flight requires paying landing fees, possibly buying more fuel, paying the crew more, and delaying the time when the aircraft could be used for another flight. Diverting flights causes problems for the airline because they have to reschedule the aircraft and crews to get back on schedule. In some cases, the crew would have run out of time when it could fly that day or that month; if so, an alternative crew would have to be transported in or the crew would have to wait until they were permitted to fly again.

Deregulating the airlines has led to tight scheduling of crews and aircraft. Delays are costly because they have a tendency to snowball. Crews now work more hours on average and so there is less of a cushion if a flight is delayed. Often the crew is simply precluded from working more hours by FAA rules.

The cost to passengers is the additional time required for travel plus the cost of missing scheduled meetings. For example, many trips are made for specific meetings; a delayed flight means that the purpose of the trip is vitiated. It takes an airline hours to charter a bus, unload the luggage, and get the luggage and passengers on the bus. There is then travel time to the other airport. Thus, the delay can be at least three hours, perhaps much more, if the airport is distant. If we value the time of the passengers at perhaps \$20 per hour, half the average wage rate, the cost of delay is at least \$60 per passenger. For a flight with 100 passengers, this would be \$6,000 for the passenger delay, perhaps \$1,000 for the bus charter, perhaps \$1,000 for crew delay, and \$2,000 to reposition the aircraft when the original airport is open. Thus, the direct cost of diverting a flight with 100 passengers is perhaps \$10,000, plus the unhappiness of passengers. The costs to the airline of having to reschedule the crews and aircraft because of the diversions are perhaps many times the direct costs.

For example, the San Francisco airport is often closed by fog in the morning. Flights into SFO are delayed until the airport opens, rather than diverting the flights to Oakland or other nearby airports. For a busy airport, such as O'Hare, Hartsfield, LAX, or LGA, diverting flights for an hour or a day would be extremely costly. If the authorities saw a large threat and decided to close an airport, any flight that had not already left, would be ordered to return to the gate. A few flights in the air would be diverted, but this would be a small proportion, compared to the number of flights that never left the airport.

If passengers were informed when they arrived at the airport or before leaving for the airport that their flight was cancelled, the cost would be canceling the trip, shifting to an alternative mode, or delaying the trip. The RAND report estimates some of these costs.

To summarize: Diverting an aircraft is expensive, with direct costs of at least \$10,000 and indirect costs due to problems with rescheduling aircraft and crews likely to be several times larger. But few flights would be diverted. Instead, flights would be held at the home airport until their airport was clear.

Immediately after the crash, the airport would need to deal with passengers at the airport. We recommend that **the FAA or DHS think about developing a protocol for what to tell passengers about what occurred and whether they should leave the airport because no flights would operate in the near future.**

The police would have to divide their attention between catching the terrorist, helping at the crash site, and evacuating the airport. Attempting to catch the terrorist could result in a blockade of the area with massive traffic jams. Again, we think that it would be useful for DHS to have a **protocol about how to balance the needs of airport passengers and personnel, as well as people living in the area or seeking to drive through the area against catching the terrorists or deterring future harm.**

At the crash site, there would be investigation and eventual clean up. If the crash affected structures around the airport both investigation and clean up would be expanded to those as well. In such a case, repair or reconstruction would be needed.

The Reaction of the FAA and DHS

How should the FAA and DHS react to such terrorist attacks? Here are some scenarios of the nation's reaction to such attacks in increasing severity:

- Only attacked airport(s) closed (including surrounding area) – this is likely to happen only if a single attack or multiple attack were confined to one location
- Airports in a geographic area are closed; only the flights bound for this region area diverted –this is likely to happen only if a single attack or multiple attack were confined to one location
- All major airports are closed, all international flights are diverted
- All airports or the entire airspace is closed, all international flights are diverted – most likely, at least initially
- In addition to the air space, other parts of the infrastructure are also closed, for example, sea ports, bridges in major cities (NY, W DC, SF) - unlikely – didn't happen in 9-11

Drawing on the 9-11 experience, the airport and airspace might be closed for 2.5 days or longer. After 9-11, airports could have been opened sooner. When the airports reopened after 2.5 days, there was no additional screening equipment or new screeners. There were additional police and National Guard, but the main difference was that the screeners were told to be more careful and cautious. While the nation waited for better screening equipment and better trained screeners, the government apparently decided that suspending air travel was so costly that they would not wait until sky marshals were trained or cockpit doors were replaced.

A ground attack could lead to a much longer closure: Countering the 9-11 attack required more careful screening of passengers, reinforcing the door to the cockpit, and placing air marshals onboard. An attack from the ground could not be deterred so easily. It is simply infeasible to bar all people from the area around airports from where a MANPAD could bring down an aircraft. Since there is no action that could be taken quickly to prevent a future attack by these portable weapon systems, the airspace might be closed for a long time, until economic costs forced a resumption of flights.

A terror threat is likely to close an airport for more than an hour, or even a day. Unfortunately, MANPADS and other weapons are portable. Closing LaGuardia would just induce terrorists to drive to Kennedy or Newark. Closing the three New York City airports would prompt terrorists to drive to Philadelphia, Hartford, Baltimore, etc. Thus, closing one airport in an area makes little or no sense. But what sort of information would be required

to get government officials to close all the New York or NE airports? Even if the NE airports were closed, the terrorists are less than a day's drive from Pittsburgh, Cleveland or Chicago.

Terrorists need not be in a hurry: Once they are armed, they could attack today, next week, or next year. Are we willing to close all airports indefinitely because there is a terror threat? Even if the authorities had exact information that terrorists were going to attack La Guardia at 2 PM in a week, they could not just close LGA for one hour - or even one day. The FAA and DHS would also have to close the other New York airports, other nearby airports, etc. and keep them closed for some time. If the terrorists were not caught, when would the authorities reopen the airports?

After an attack, the FAA and DHS would not have to explain why they closed an airport. However, they would have to explain why they had decided to reopen the airport. That explanation would have to say that they believe that they could prevent or deter a future attack. Since the USA has many investigative journalists and independent experts, the FAA and DHS would need to make a credible case as to why they thought that the threat had receded. We recommend that the FAA and DHS recognize the nature of the explanation that they would need to give for reopening an airport before deciding to close it. After 9-11, the airports were reopened when nothing had changed other than telling the air traffic controllers to be more careful and having National Guardsmen at the airports. The latter would not have helped to prevent another 9-11 attack. In a future event, critics are likely to be more vocal, asking why it is now safe to fly: "It apparently wasn't safe when you closed the airport, and you have done little or nothing to prevent this type of attack."

In summary, we recommend that the FAA and DHS think through three issues in advance of taking an action that it would be embarrassing to reverse. First, should airport closure be local, regional, or national? Second, should airports be closed be for a day, a week, or longer? Third, under what conditions should one or more airports be reopened? The portability of MANPADS and other weapons means that closing a single airport is unlikely to prevent terrorists from mounting an attack at a nearby airport. Similarly, closing all airports for a day is unlikely to stop a future attack. Short of catching all terrorists, it would never be completely safe to reopen airports. The 9-11 attacks were unprecedented and so officials had to make quick judgments. In contrast, the attractiveness of attacking commercial aircraft in flight and the proliferation of weapons that could down an aircraft mean that DHS has time to study these issues and develop protocols. We recommend that the FAA and DHS study the issues and formulate protocols to deal with these three issues.

Reopening the infrastructure could happen gradually, starting with facilities that are least threatened, or all at once. It is possible that the affected airport(s) stays closed longer than other airports. A more costly possibility is that airports could be reopened with severe restrictions on when flights could be scheduled, how many could be scheduled, what type of aircraft, etc. Such restrictions would reduce the airport's capacity and require the airlines to go through a complete rescheduling of their aircraft and crews, expending the economic impact indefinitely. In the worst case, even though commercial service was possible, restrictions could be severe enough to make commercial aviation an unattractive business.

Long-Term Consequences

It is clear from the 9/11 attack, that the nation's confidence in flying can survive one attack, even as horrendous as that was. There was a decline in air travel, but people did not stop flying.

After 9-11, revenue passenger miles fell, available seat miles declined later, and airlines lost revenue. Air travel demand still has not yet fully returned to pre 9/11 levels, but more and more people are flying again. See graphs of RPM, revenues, ASM, and profits from 2000-2004 in the Appendix.

The first graph shows what happened to the entire industry over this period. The next graphs show the same data for American Airlines, United, Delta, and US Airways. Travel at all these airlines fell.

Although the terrorist attack discussed here would not be the first terrorist attack in the US, such an event is likely to be traumatic. But how traumatic would it be? Likely not as traumatic as the terrorist attack on Sept 11th, since it would be on a much smaller scale. Likely it would be more traumatic than a single plane crash before 9/11 because of the terror factor. But it is impossible to gage just how traumatic the event would be and how the nation's psyche would react. Multiple attack on airplanes could be more devastating for the airline industry than 9/11, since there was some public assurance after 9/11 that security measures had been increased to reduce the risk of hijacking. In the MANPADS attack it would be much tougher to give such assurance. A London-type repeat attack a few days or weeks later would increase this effect.

The event that might have the smallest effect would be one single unsuccessful attack after which the terrorist are apprehended. People would feel less safe if the terrorist are not caught. However, if the first attack were not followed by consecutive attacks, then the nation's confidence in flying could return again. After all, not all terrorist were apprehended after 9/11 either. A successful attack with the terrorist caught would have still stronger effect on the public and so on.

The most devastating effect would result from a series of successful attacks. Likely whether any, some, or all of the attacks were successful is less important than the fact that the terrorist were able to execute a series of attack, proving that the government cannot protect its citizens. Whether any of the terrorists were caught would also reflect on the government's capabilities to this regard. Even if some were apprehended, the ability of others to continue the attacks would reflect badly on the government.

We do not know how people would react to a continual terrorist threat over time. Judging from 9-11 and crashes resulting from error rather than attack, many people would not want to fly until the terrorists were caught or some time had passed. Some intrepid people would want to continue

flying. If there were considerable media hype, people's reaction could get increasingly worse, resulting in a panic, much like in the case of the Washington sniper. Such reactions would put considerable financial strain on the airlines and the nation. After some time had passed, some people would get saturated by the constant threat and accept the terrorist threat as part of living in the 21st century. In any case, the scenarios would likely result in a reduced level of air travel demand. Quite likely, the nation's reaction to continuous terrorist threat would be a succession or combination of these as people accept the new realities and adjust their lives accordingly.

To simplify, after the immediate reactions have taken place, there are three possibilities for the long-term. First, commercial aviation could return to business as usual, with an occasional terror attack, in analogy to the occasional accidental crash. Second, the current restrictions on flights and amount of passenger screening could increase, along with patrols to keep terrorists away from the airport perimeter and defensive systems on aircraft. Third, all commercial flights could be suspended for a period of time – perhaps a week or month or year. The one certain consequence of an attack is that airline revenues would fall and they would lose money. Eventually, airlines would have to downsize, reducing the number of aircraft, crews, and flights. That is likely to be an expensive painful process, since many people would continue to believe that passengers would return if only they waited a little longer.

Perhaps contrary to the expectations of most people, the first option, going back to business as usual with an occasional attack, would be the least costly strategy, as long as most people decided that flying was still sufficiently safe. Each successful attack would cost about \$1 billion (RAND). If the reaction of the public were that an occasional attack was tolerable, this outcome would be the desired one.

Tightening airport security and putting countermeasures on aircraft would be much more expensive. Airport security measures would cost billions of dollars per year, as the more intensive screening since 9-11 has shown. Countermeasures on the entire commercial aircraft fleet are estimated to cost \$11 billion for just the laser-jamming device. Annual operation and support cost for this defense system is estimated at \$2.1 billion. “The full ten-year life-cycle cost for developing, installing, operating and supporting laser-jammer countermeasures are estimated to be \$40 billion” (RAND). These measures would not prevent all crashes, but should give the public more confidence in the safety of flying.

Suspending air transportation would be the most expensive reaction. This third option is estimated to cost \$2.5 billion per day of suspension. The US economy depends on air transport for both passengers and freight. Eventually, some partial substitutes could be found for transporting both passengers and freight, but they would not offer the speed. In the short term, not having air transport would deal a major blow to the economy, as 9-11 demonstrated.

The best option depends on both the costs outlined above and the reaction of the government, media and public. If the attack caused widespread terror, the third option might be the only one possible. If the public regarded the attacks as simply an unfortunate aspect of 21st century life, the first option could be much less costly.

When considering the long term affect of such terrorist attacks, we need to look at the

- a) affected airline
- b) targeted airport
- c) the airline industry
- d) industry sectors supplying the airline industry
- e) industry sectors supplied by or affected by changes to the airline industry

COST ESTIMATION

If the loss of a commercial airliner is regarded as unacceptable, commercial aviation could be shut down for years. If the economic costs of a shutdown proved to be unacceptable, commercial aviation might be resumed under severe restrictions.

Navarro and Spencer² summarized the cost of terrorism as a result of the attack on September 11, as shown in Table 2. In our report we will follow these categories and attempt to quantify the cost of the immediate aftermath, microeconomic and sector specific costs and the costs of suspending commercial air service for the terrorist scenarios presented here.

² **September 11, 2001, Assessing the cost of terrorism** by Peter Navarro and Aron Spencer, The Milken Institute Review (fourth Quarter 2001)

Table 2. Cost Categories for Terrorist Attacks (Navarro, Spencer 2001)

TERRORISM

EXHIBIT 1: COST CATEGORIES FOR TERRORIST ATTACKS

THE IMMEDIATE AFTERMATH

- Property damage
- Loss of human life and injuries
- Lost economic output
- Reduction in stock market wealth
- Psychological impacts of terrorism

LONGER TERM MICROECONOMIC EFFECTS OF A "TERRORISM TAX"

- Increased airline security
- Other security measures

SECTOR-SPECIFIC IMPACTS

- Advertising
- Airlines
- Insurance
- Hotel and tourism

GOVERNMENT BAILOUTS AND BUDGETARY IMPACTS

- The airlines
- New York City
- Reduced federal, state and local tax revenues

THE HIGHER OIL PRICES-WEAKER DOLLAR CONUNDRUM

- Effects of an oil price shock
- Costs of a weaker dollar
- Destabilization of the stock market and international monetary system

MACROECONOMIC COSTS

DRAFT

- A deeper recession
- A more volatile business cycle
- A lower long-term growth path and economic

9-11 has cost the US airlines tens of billions of dollars in losses. The financial problems led the airlines to renegotiate labor and equipment contracts, leading to substantial cuts. Industry suppliers have also suffered. The drop in traffic caused some airlines to use up their financial reserves and go into Chapter 11 bankruptcy. Possible future suspension of commercial air service would deepen the airlines financial troubles. Finally, cities, such as Pittsburgh, PA were hurt by the constrained schedules as a result of 9/11. If airports were closed because of the terrorist threat or attack, more regional economies would be harmed. These are real costs to individuals, companies, the airlines, regions, and the national economy. However, the detailed costs as well as the macroeconomic effects of decreased air traffic are beyond the scope of our analysis.

IMMEDIATE AFTERMATH

Loss of human life and injuries

- The passengers and crew of the plane
- Lives lost at crash site

Navarro and Spencer indicated that the federal government uses a number between \$3 million and \$7 million in deciding whether to mandate additional safety equipment in commercial aircraft. The payoffs for 9-11 deaths were lower.

Lost economic output in the immediate aftermath

There would be immediate economic impact of a terrorist attack and the resulting closure of the airport.

- Lost airline and cargo shipping revenues: In the worst case, the entire air transportation system would be shut down completely again. In the case of 9/11 a 2.5 days complete shut down cost \$1.5 billion in lost air fares and cargo-shipping revenues (Navarro and Spencer). If the entire air space over the US were shut down, not only commercial aviation but also smaller industrial aviation (such as crop dusters and traffic helicopter) would be grounded, increasing cost.
- Loss to prospective passengers of not being able to fly
- Loss to the hotel and resort industries - room cancellations (this depends on how much of the air space is closed and for how long)
- Loss to the television and radio stations running commercial free coverage of the situation (this will be much lower) – foregone advertising revenues

- Partial work stoppages as people absorb the news and adjust to it. (This should be shorter than the 9/11 case)
- Cancellation of events drawing major crowd – such as sport events – will also result in lost economic activity
- Lost consumer spending and retail sales

The airlines and their supplies would suffer the most direct losses. They would face a spending reduction of \$637 million per day while grounded. Would the targeted airline(s) fare worse than the rest of the airlines? Sakata³ concluded that media coverage of airline crash greatly influences whether people choose to avoid an airline after a “natural” crash. Sakata examined three cases: (1) ValuJet 592 crash (May 11, 2001), which received extensive news coverage and was followed by a 21% reduction in ValuJet’s load factor; (2) TWA 800 (July 16, 2001), which too receive considerable media coverage, was followed by a nearly 14% decline in TWA’s load factor; and (3) AA 587 (November 12, 2001), which did not receive media attention and was not followed by any decline in AA’s business.

Based on data from the Bureau of Transportation statistics below (Table 3), American and United, the carriers whose planes were hijacked on 9-11, had some passengers avoid them immediately after 9-11. The table below shows that they had a slightly greater decline in revenue passenger miles and enplanements than the other major carriers. (USAirways is a special case since one of its major hubs, the Ronald Reagan Washington International Airport, was closed during September). We can therefore assume that the airlines whose planes were downed would suffer more.

³ Sakata, Nobuyo, **Economic Impact of Airplane Crash Media Coverage on Airline Business Performance**, Aviation Institute, The George Washington University, May 2003

Table 3. Airline Operating Statistics Percent Change between August and September 2001

Percent Change from August 2001					
Source: Bureau of Transportation Statistics					
Data Bank: 28DS					
	Revenue Passenger Miles	Load Factor	Enplanements	Departures	Available Seat Miles
Carrier	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)
Total System	-43.2	-24.1	-45.6	-25.1	-25.2
American	-44.2	-22.2	-47.5	-31.7	-28.3
United	-43.2	-22.1	-48.4	-33.0	-27.1
Delta	-42.8	-26.7	-45.6	-23.2	-21.9
Northwest	-40.7	-20.8	-46.8	-28.0	-25.2
Continental	-43.2	-21.3	-46.5	-32.1	-27.9
US Airways	-46.0	-26.3	-48.9	-30.5	-26.7
Southwest	-40.6	-30.7	-42.3	-15.8	-14.3
TWA	-52.4	-30.7	-49.2	-22.7	-31.3
America West	-40.8	-25.2	-40.5	-19.4	-20.9
Alaska	-45.4	-19.1	-44.8	-30.4	-32.6
American Trans Air	-48.3	-24.4	-50.3	-29.5	-31.6

In addition to the airlines, other businesses would suffer losses. Even short disruption in cargo delivery could result in significant economic losses due to perishable goods and because of the time-sensitive nature of many air shipments. In our air transportation dependent economy, even short airport closures can cause major disruptions in just-in-time delivery businesses.

Airport businesses, such as terminal shops and in-flight services would have to close immediately and could not reopen until the airport is reopened. Until the airport reopens, even postal services would be affected.

Hotels, taxi cabs and rent-a-car businesses would experience a short-term gain due to stranded passengers. However, once these passengers are gone, these industries suffer continuing losses until travel demand returns to pre attack levels.

Short run reduction in stock market wealth

As a result of the attack on 9/11 the US stock market closed between September 10 and 21. The NYSE and the NASDAQ indexes suffered double digit drops. Other markets around the world also suffered losses.

In case of an attack on commercial aircraft, the US stock market need not close down. However, it is likely that the markets would suffer losses. We accept the stock markets response to a natural crash as a lower bound to the loss. However, it is hard to establish an upper bound. It is reasonable to assume that the markets would react stronger to another attack on a commercial aircraft than to a natural crash.

Psychological impact of terrorism

Navarro and Spencer use contingency valuation to think about how much people would be willing to pay for eliminating the terrorist threat of 9/11. We need to ask the same question as Navarro and Spencer asked: “How much would we pay to be able to fly without fear?” They estimate that if “each of the 100 million households not living in poverty would give up a mere \$1000 to be able to forget” about Osama Bin Laden and the threat his personifies, the emotional damage of 9/11 would be measured at \$100 billion.

The terrorist attack we discuss here would be smaller than that on 9/11. It would only affect those who travel by air or whose jobs are related to the industry. If, for example, all air travelers were willing to pay 1 cent more per mile traveled to eliminate this threat, then the impact would be \$6.6 billion per year.

LONGER TERM MICROECONOMIC IMPACT

Microeconomic impact of airport closure

Airport closures can have serious economic impact on each regional economy and disrupt urban services. While there will be federal decisions, regional governments also need to understand the economic and social implications of an airport closure. In this section, we discuss the potential impacts of closure of a major airport due to a terrorist attack; the length of closure and other restrictions would be determined by the federal

government. Our discussion is mainly based on Chang, Ericson, and Pearce⁴ in their paper prepared for the Office of Critical Infrastructure Protection and Emergency Preparedness, Government of Canada.

9/11 affected all airports in the USA since the entire civilian air space was closed for 2.5 days. The most severely affected airport was the Ronald Regan Washington National Airport in Washington DC, which was closed for 23 days and was only gradually reopened in four phases over the next six month.

Travel demand reduction at Ronald Regan Washington National was dramatic. Even before 9/11, there was a general decline in travel demand due to general economic slowdown in the US. After 9/11, general travel demand dropped as people were afraid of flying. In addition, there are two other major airports in the region: Dulles International and Baltimore-Washington International Airports. Although they are much less convenient for passengers going to and from Washington, DC, these two airports were able to pick up most of the travel demand that was originally at Ronald Regan Washington National. In October 2001 travel demand was only at 18% of October 2000, as of mid-December it was at 47%. (Chang, Ericson and Pearce, 2003)

Impact on cargo shipping was limited because the Ronald Regan Washington National is not a major cargo center. Furthermore, impact on the regional economy was reduced by the availability of two other airports (Dulles International and Baltimore-Washington International Airports) in the region.

The economic impact of the long term closure of the Ronald Regan National Airport in Washington DC is discussed in Chang, Ericson and Pearce, 2003, which we summarize here.

“The lengthy disruptions at Reagan National Airport caused substantial losses to regional businesses. The recovery has been very slow, and general aviation (including corporate aviation) has, as of this writing, yet to recover. It has been estimated that the economic impact of the closure was “\$330 million per day to the airport and Northern Virginia businesses and \$27 million to state and local tax revenues” (Rubin and Renda-Tanali, 2001: 9; citing *Business Week*, October 22, 2001: 102). Individual businesses at the airport reported as much as a 60 percent loss over the fiscal year due to the closure, the fact that the airport was not operating at capacity when it reopened, and the nationwide reductions in passenger volumes.” (Chang, Ericson and Pearce, 2003)

⁴ Chang, Stephanie.E.; Ericson, Diana; and Pearce, Laurie; **Airport Closures in Natural and Human-Induced Disasters: Business Vulnerability and Planning**, Office of Critical Infrastructure Protection and Emergency Preparedness, Government of Canada (2003)

The long term closure of the Ronald Regan Washington National and restricted reopening had economic impact on the following sectors:

- Airlines
- Tourism and hotel
- Businesses at the airport
- Taxicabs
- Fixed-base operators (charter corporate jets)

The greatest impact of Ronald Regan Washington National airport closure was on the airlines, especially United and USAir, helping to push them into bankruptcy. USAir would have gone out of business had Ronald Regan Washington National not reopened (Chang, Ericson and Pearce, 2003). The airlines still have not recovered from the effect of 9/11 as air travel demand has still not returned to its pre 9/11 level.

Businesses at the airport were affected by the closure and later by the reduced passenger traffic. Furthermore, now passengers spend their time in security lines, not in shops. Small, independent businesses were especially vulnerable because they could not survive the almost month long closure.

Tourism is a major factor in the DC area economy. The drop in air traffic hurt related businesses, such as hotels, rental cars, restaurants, entertainment, as well as convention businesses.

Hotels, especially those at or near the airport suffered the greatest impact in this sector. “Overall hotel occupancy in October 2001 dropped 16 percent compared to the previous October. Hotels reacted by cutting price to fill their rooms, leading to a 25 percent drop in room revenues. Many hotels lowered their room rates in order to generate business and remain in operation (Arlington, 2001). Annual statistics show that hotel occupancies in the region had recovered by 2004. Average occupancy rate in 2000 was 73.7 percent. In 2001, it was 68.7 percent, and in 2002, it had dropped even further to 67.7 percent (Holzheimer, 2003).” This happened in addition to the effect of the general economic downturn.

Taxicab drivers were hit hard as well. “Some 25 percent of local taxi demand is attributable to Ronald Regan Washington National Airport. Cab operators relying on airport traffic reported a 60 percent drop in demand, while those with less airport dependence reported a 15 percent drop.” (Chang, Ericson and Pearce, 2003)

In general, it seems that the magnitude of the impact and the time period required for recovery are determined by several factors, among them:

- Passenger and cargo traffic of the airport before closure
- The airport’s share in the local economy before closure

- The length of closure
- Any restrictions on airport operation after reopening
- Availability of other airports that are operating in the vicinity that are capable of taking over cargo and passenger travel while the affected airport is closed.
- Whether the airport closed was a major cargo hub
- Whether it was a major export port for goods.

We generalize the costs of airport closure beyond the Chang, Ericson and Pearce estimates for Ronald Regan Washington National airport and Vancouver International Airport. Appendix 2 is adapted from Chang, Ericson and Pearce. They provided a summary of the economic impact of airport closure by stakeholder groups. Even though the authors acknowledge that their list is not comprehensive or complete, it is the best and most comprehensive source we could find on the impact of airport closures to the regional economy. Chang, Ericson and Pearce have already taken the first steps in preparing a business response that would lessen the economic impact of airport closures.

Increased airport security

The security measures taken as a result of 9/11 are designed to prevent passengers from boarding planes with weapons or explosives. None of these measures would prevent a ground attack on an aircraft. For a short range weapon such as a rifle or RPG, the airport and immediate vicinity would have to be protected. A MANPAD would be most effective if it were fired some distance from the airport. DHS might undertake a survey of what nations such as Israel, South Korea, etc. have done to ensure the safety of their airports.

Securing the area where an RPG or rifle could be effective would require restricting activities in the commercial and residential areas around airports. Police checkpoints would harm businesses and pose inconveniences for those living in the area. If such measures continued, properties around the airport would lose some of their value.

The government may decide to equip airports and aircrafts with antimissile defense systems. These systems would not protect against all attacks, but would give some measure of protection. The public may pressure the administration into taking this step.

A study by the RAND Corporation estimates that “it would cost about \$11 billion to install a single laser-jammer on each of the 6,800 commercial aircraft in the U.S. fleet. The operating costs of fleet wide countermeasures will depend on the reliability of the system. Extrapolating from early reliability data from the systems currently deployed on large military aircraft, the operating and support (O&S) costs for a commercial variant were assessed to be \$2.1 billion per year for the entire commercial fleet. The full ten-year life-cycle costs (LCCs) for developing, installing, operating, and

supporting laser-jammer countermeasures are estimated to be \$40 billion. If reliability goals recommended by the Department of Homeland Security (DHS) can be achieved, the ten-year LCCs are estimated to be \$25 billion.”

Increased security (check points) toward the airport would result in traffic delay. Such traffic delays would affect everyone in the vicinity of an airport, not only those who travel to and from the airport. Transportation studies show that “people place a value of \$10 per hour on time spent in their cars, while studies of air travel put the cost at a two to four times that much because air travelers have higher average income.” (Navarro and Spencer) Airports have become centers of activity for hotels, car rentals, air freight, and other businesses. In the long run, these businesses are unlikely to stay within the restricted parameter and so a great deal of expense would be associated with moving the businesses outside the restricted area.

LONG-TERM SECTOR SPECIFIC IMPACT

Employment

Navarro and Spencer (4th quarter of 2001) identified four industries that suffered greatly from the terrorist attack of 9/11: advertising, airline, insurance and hotel/tourism.

DeVol⁵ in a paper published in August 2002 presents data on changes in employment as a result of the 9/11 attacks. He identified travel and tourism as especially hard hit. About a year after the attack, air travel demand was down by 10-15 %; foreign travel to the US was down 20-25%.

Less travel and tourism has hit the hotel and motel industry hard. Eating and drinking places (restaurants and bars) were hit hard by lower sales as well. Table 4 from DeVol’s updated report shows the net job losses in June 2002 due to 9/11.

⁵ “The Impact of September 11 on US metropolitan Economies” Updated 9/11 Economic Impact, DeVol, Ross; Milken Institute, August 2002 (based on data till June 2002)

Table 4. Net job losses between 9/11/2001 and 6/2002 as a result of 9/11 (DeVol)

3-digit SIC Most Impacted Industries, Relative to Baseline (No 9/11, general economic slow down taken into account)	
Post-September 11 U.S. Metropolitan Area Employment Outlook, Estimate	
	2002 Net Job Losses (in Thousands)
Eating and drinking places	135.6
Hotels & motels	123.3
Miscellaneous amusement & recreational services	118.7
Air transportation	76.8
Advertising	48.7
Aircraft & parts	43.6
Theatrical producers, bands & recreational services	38.7
Airports and airport terminal facilities	16.1

The terrorist attack scenarios discussed here are not as big as the attack on September 11 was, but is likely to have a longer lasting effect. The resulting losses to the US economy would be vast, from the airline industry to aircraft manufacturing and servicing to hotels, resorts, shipping, and many other sectors.

GOVERNMENTAL BAILOUT AND LOST TAX REVENUES

Bailout of the airline industry: After 9/11 Congress approved a fund of \$10 billion to help the airline industry. Most airline costs are fixed, at least in the short run. 9/11 and longer term trends in the industry put the major airlines in bankruptcy or on the brink of bankruptcy. A further blow to the airlines, such as a MANPAD attack would put almost all airlines into bankruptcy and lead some to cease operation. Preserving a major airline industry in the US would require government intervention in the event of a MANPAD attack.

The Economic Cost of Suspending Commercial Air Service: After 9-11, the possibility of other hijackers taking over aircraft or forcing them to crash was being weighed against the inconvenience of passengers and the cost to the economy of continued suspension. Countermeasures, such as better passenger and baggage screening equipment, better training of screeners, reinforced cockpit doors, and the presence of air marshals on flights were available at the time when commercial flights were allowed to operate again, but could not be implemented on all aircraft and all airports immediately. (Ronald Regan Washington National Airport was kept closed for almost a month and then was allowed to operate only with severe restrictions). Thus, after 2.5 days, federal officials regarded the cost to the economy of continued suspension to be greater than the risk of a hijacking.

SUMMARY

The air transportation system is an attractive target for terrorists. Using widely available weapons, terrorists could shoot down a passenger airliner. This disruption would be magnified if the attack caused terror in the general population and led government officials, the media, and the public to engage in costly preventive actions. Although various defenses could be mounted against attacks by missiles, rocket propelled grenades, and high powered rifles, no countermeasure could protect against all of them or even be completely successful against MANPADS.

The immediate effect of shooting down an airliner would be hundreds of deaths and a cost to the airline of about \$1 billion for the aircraft and payments to the survivors of deceased passengers, as well as reduced demand for all air services. An unsuccessful attack could lead to the same disruptions in transportation and business losses. Closing an airport for more than a few days would throw thousands of people out of work and generate losses to the surrounding businesses and those who depend on the airport and air transport of freight. Closing US airspace immediately after the attack would cause diversion of flights, stranded passengers, and major costs to the airlines and travelers.

If a terrorist managed to shoot down a large passenger aircraft and this resulted in grounding all aircraft for 2.5 days, the loss to the economy would be \$1 billion for the air craft, \$1.6 billion in reduced airline and associated spending, and \$4.75 billion in losses to business and leisure passengers. The total cost of \$6.3 billion per 2.5 days (or \$2.5 billion per day) makes a ground attack against commercial aircraft a tempting target. There are few areas in the USA where a lone terrorist with readily available weapons could inflict such a high cost on the economy, and possibly cause widespread terror.

We classify the long-term reaction to a terrorist attack on an airliner into three general scenarios. First, even a successful attack could be regarded as one of the unfortunate aspects of living in the 21st century. Some additional protection would be provided to airports, but air transportation would go on as before. Second, airports and airliners could be given the best available protection against attacks. This would include anti-missile defense systems on airliners and increased airport security and patrols or keeping people far enough away from the airport to keep aircraft out of the range of rocket propelled grenades (RPG) and large caliber (LC) rifles. Third, all non-military aviation could be suspended for a period ranging from days to years.

The first scenario would be least costly, unless the terror attacks managed to bring down more than a few large aircraft each year. At \$1 billion per successful attack, the dollar costs would be less than the other two alternatives, assuming that people were still willing to fly.

The second scenario involves equipping all commercial airliners with a laser system to deter missiles; it is estimated to cost \$11 billion. Annual operation and support cost of this defense system is estimated at \$2.1 billion. This system would be effective against some, but not all shoulder fired

missiles, and would not help against RPGs or LC rifles. To guard against the latter, airport security could be extended to keep private vehicles away from the airport and have frequent patrols in the area where an RPG or rifle could down an aircraft. In the extreme, airport perimeters could be extended at least one-mile so that a terrorist at the fence would be at least 1-2 miles away aircraft taking off, landing or taxiing. Flight path would be restricted and flights would be scheduled for daylight hours only. Airports embedded in urban areas would be the hardest to protect. These airport restrictions are likely to be more expensive than equipping all aircraft with countermeasures.

The third scenario, ending commercial aviation temporarily, is estimated to cost \$2.5 billion per day in lost revenue to airlines and their suppliers and losses to passengers as measured by consumer surplus. In addition, the regional economy around each airport would suffer from lack of business and not being able to ship cargo in or out. Preventing exports and imports by air would add to mounting costs. The national economy would suffer a slower growth rate and reduced productivity from not having air transportation available.

The most valuable DHS program would be one that prevented all attacks; that is impossible. If DHS could protect all aircraft in case of attack, that would be next most valuable. However, no single countermeasure or group of countermeasures is capable of offering full protection. As shoulder fired missiles become more sophisticated, the old defense systems would offer less protection. The most costly option would be grounding all commercial flights.

We conclude that the US Government should do what it can to prevent terrorist attacks on aircraft and take measures around airports that make it more difficult to mount an attack. Perhaps more important than actions to prevent downing a commercial aircraft is a campaign to prevent widespread panic if an attack occurs. We think it likely that terrorists will target aircraft and that they will mount a visible attack, possibly succeeding in downing an aircraft. The vast majority of the resulting cost to the economy would be avoided if the public does not panic and if the government does not require costly actions designed to reassure the public, but which have little efficacy in preventing further loss. This program requires warning the public about the possibility of an attack and translating the reaction following an attack into a rational, rather than panic response. One goal would be to get the public officials, the media, and the public to understand that attacks against airlines cannot be prevented, that closing US airspace is not a reasonable policy, and that countermeasures at the airports or on aircraft should be evaluated for effectiveness and cost-effectiveness before they are implemented.

We recommend that the DHS and FAA study and develop protocols to address three issues: (1) Should a terrorist attack lead to airport closure be for a single airport, airports in a region, or all airports in the nation? (2) Should closure be for a day, a week or longer? (3) Under what conditions should airports be reopened? Other issues to be studied include what to tell passengers, flight crews, and airport employees following an attack, how to balance the immediate need to find the attackers with the disruption that closure and search would cause, and how to balance the need for security with inconvenience to employees, passengers, and people living near the airports.

