THE CASE FOR RISK-BASED AVIATION SECURITY POLICY

Robert W Poole, Jr

Abstract

In the wake of the 9/11 attacks, governments in the United States (US), Canada, and Europe implemented additional aviation security measures. Although the rhetoric of risk-assessment is often heard, actual policy was driven largely by political imperatives to reassure frightened populations that air travel was still safe. The challenge in dealing with terrorist threats is always one of deciding where to invest scarce resources to maximum benefit. This inevitably requires difficult choices. The premise of this paper is that risk assessment provides an essential framework for making such choices and should be applied more consistently to aviation security.

The goal should be to wean legislators away from enacting mandates not based on risk analysis. Legislators should direct the national aviation security policymaker/regulator to address problems within some kinds of quantitative parameters. Details of making actual policy and resource-allocation decisions should be left to the aviation security agency. That agency, in turn, should be flexible in tailoring policies to changing threats and different situations at individual airports which vary enormously in type, size, and configuration.

While it seems likely that commercial aviation will remain a high-profile potential target, spending billions every year on static defences at airports is almost certainly a poor use of resources. Whether any kind of effort can succeed in educating elected legislators and opinion leaders to these realities is the most difficult challenge.

1. Introduction

In the wake of the 9/11 attacks, governments in the United States (US), Canada, and Europe implemented additional aviation security measures, among them strengthened (and locked) cockpit doors, 100 per cent screening of checked baggage, more thorough screening of passengers and their carry-on baggage, increased use of on-board security officers, increased attention to air cargo, and greater attention to airport access and perimeter control.

Although the rhetoric of risk-assessment is often heard, actual policy was driven largely by political imperatives to reassure frightened populations that air travel was still safe. In the US, the initial legislation created the *Transportation* Security Administration (TSA), but the vast majority of its budget has gone for legislatively mandated *aviation* security. No risk assessment preceded this statute's enactment, nor has this initial allocation of resources been changed significantly by the subsequent creation of the Department of Homeland Security (DHS), into which the TSA and many other agencies were transferred.

Economics reminds us that resources are always limited, and that resources allocated to X are not available for Y. The challenge in dealing with terrorist threats is always one of deciding where to invest scarce resources to maximum benefit. This inevitably requires difficult choices. The premise of this paper is that risk assessment provides an essential framework for making such choices and should be applied more consistently to aviation security.

2. Context: The problem of defending against terrorism

The sector-specific approach applied to aviation is an example of target-hardening. Because we live in a target-rich world, all conceivable targets cannot be hardened. Terrorists can readily shift from hardened to non-hardened targets. Thus, target-hardening is one of the 'asymmetries' between terrorists and their target governments. As Sandler, Arce and Enders (2008) point out, because terrorists hide among the general population, they present a target-poor environment to governments, compared with the terrorists' target-rich environment. And the costs to terrorists of wreaking destruction and creating fear are modest in comparison to the costs of governmental attempts to defend (everything) against terrorist attack.

The Maginot Line is a classic case of target-hardening that failed. As Intriligator points out, '...the most effective way to defeat transnational terrorism is not to try to protect vulnerable assets. That is the principal approach of the US DHS, which concentrates on protecting airplanes and airports, ignoring other potential targets. Such an approach is like generals fighting the last war, in this case the 9/11 attacks' (Intriligator 2008, p. 17).

Terrorists adapt to the creation of defences. In *Breaching the Fortress Wall*, RAND Corporation analysts sought to understand terrorist efforts to overcome defensive technologies (Jackson et al. 2007). They found that terrorist groups respond to the use of defensive technologies by:

- altering operational practices
- making technological changes or substitutions
- avoiding the defensive technology, and/or
- attacking the defensive technology.

The RAND researchers concluded that 'the historical record of terrorists' efforts to counter defensive technologies is not encouraging'. They found that 'for most technologies, the groups will adapt to circumvent them' (Jackson et al. 2007, p. 125) and the security forces will have to respond. Thus, technology cannot be 'the' solution to terrorism. They recommend that new defensive technology systems 'must be designed with terrorist countertechnology behaviors and past successes in mind' (Jackson et al. 2007, p. 126). In particular, they suggest designing flexibility into defensive technologies, and frequently testing them against 'red teams' trying to get past them.

3. An example of cost-effectiveness analysis in aviation security

A recent paper by Stewart and Mueller (2008) assesses the relative cost-effectiveness of several components of the TSA's aviation security program in the US. Their metric is the cost per life saved, as used in analyses of US safety regulations. The annual cost per life saved by a long list of such measures

(in 1995 dollars) ranges from a low of $0.1 million for Federal Aviation Administration's (FAA) aircraft cabin fire protection standard to a high of $6.78 trillion for Environmental Protection Agency's (EPA) hazardous waste listing for wood-preserving chemicals. The US Department of Transport uses a figure of $3 million per life saved as a ceiling for acceptable regulatory costs.

Stewart and Mueller (2008) present a list of 20 TSA aviation security efforts, 14 of which apply in the airport environment and six that deal with in-flight security. They group the six in-flight measures into three: crew and passenger resistance, hardened cockpit doors, and Federal Air Marshals (FAMs). Consistent with much informal thinking within aviation security circles, they assume that in-flight efforts have made a considerable difference in reducing the probability that a plane will be hijacked and turned into a weapon. Hence, their starting assumption is that the in-flight measures account for 50 per cent of the reduced risk of a 9/11 aircraft takeover, with the 14 pre-board security measures adding up to the other 50 per cent. And as a starting assumption, they assume that the three in-flight measures are each equally effective—that is, each accounts for 16.67 per cent of the total reduced risk. They then factor in a generous 10 per cent probability that FAMs will be present on any particular plane. That reduces the risk reduction due to FAMs alone to 1.67 per cent.

How likely would another 9/11 attack be were these 20 security measures not in place? Stewart and Mueller (2008) postulate that in the absence of those measures, there would be a 9/11 repeat (with approximately 3,000 deaths) once every 10 years. Hence, they assume this set of measures prevents 300 deaths per year in the US. Using the best available information on the annual costs of each measure, they conclude that hardened cockpit doors cost $800,000 per year per life saved, versus $180 million per year for air marshals. Because several of their assumptions are somewhat arbitrary, they follow this with a sensitivity analysis that varies the probability of success of each measure, showing that the general results hold true over a wide range of assumed probabilities.

This author applied their methodology to the TSA's current pre-board security measures. Using their assumption that 50 per cent of the reduced risk of a 9/11 attack is due to the pre-board measures, the calculation yields an estimated cost of $31.3 million per annual life saved for current pre-board airport security measures—more than 10 times the US Department of Transport standard, and 39 times the cost of hardened cockpit doors (Poole Jr. 2009).

While this approach obviously has its limitations, depending critically on assumptions about annual lives saved, the availability of reasonably good cost data coupled with sensitivity analysis makes it possible to estimate the *relative* cost-effectiveness of various aviation security measures.

4. US, Canadian and European approaches to aviation security

Aircraft hijackings in the late 1960s and early 1970s led the member states of the International Civil Aviation Organization (ICAO) to adopt Annex 17 to the Convention on International Civil Aviation (the Chicago Convention). Annex 17 requires each member state to designate a single agency to develop national policy on aviation security. Annex 17 has been amended several times in subsequent decades, in response to the emergence of new threats and trends. Following 9/11, Canada, the European Union (EU), and the US all adopted similar approaches to increased aviation security.

Prior to 9/11, aviation security was handled on a national basis in Europe. Airport security measures (mostly passenger and baggage screening) were introduced in the 1970s and 1980s in response to hijackings. Initially screeners were state employees, but the combination of airport privatisation and cost pressures led to the outsourcing of screening functions at most major airports by 2000. The destruction of Pan Am Flight 103 over Lockerbie, Scotland in December 1988, via a bomb in an unsuspecting passenger's checked bag, led to positive matching of passengers and bags in most European countries

by 1989. Germany implemented 100 per cent checked baggage screening at all 37 major airports by the end of 2002 (Hainmuller & Lemnitzer 2003). The United Kingdom and a number of other countries did likewise.

No EU-wide aviation security policy existed until 2002, when the European Parliament and Council agreed upon Regulation No 2320/2002 establishing common rules for civil aviation security. Those regulations were revised substantially in 2008, with Regulation No 300/2008 repealing and replacing the 2002 regulation. Consistent with ICAO Annex 17, each member state of the EU must have a national civil aviation security program, with a single agency in charge. Member states may adopt more stringent measures (on the basis of risk assessment), but the objective of No 300/2008 is to provide a 'common interpretation of Annex 17' within Europe (OJ L 97/72, 9.4.2008).

Canada's aviation security program also began as a response to hijackings in the 1970s. The government designated Transport Canada as its aviation security agency under ICAO Annex 17, and developed an airport security program based on ICAO recommendations for international airports (CATSA Act Review Secretariat 2006). Airlines were made responsible for aircraft security, with Transport Canada providing security standards for airlines and major airports (of which Transport Canada was then the owner). That agency also provided airport passenger screening. In-flight bombings in the 1980s led to stepped-up passenger checkpoint screening and physical inspection or X-ray of all checked luggage on international flights, plus the use of explosive detection system (EDS) units for checked baggage screening and the use of passenger bag matching on international flights. After 1992, when airports were divested by the national government to newly created airport authorities, responsibility for passenger and baggage screening shifted to airports and their airline tenants.

In the wake of the 9/11 attack, new legislation created a crown corporation, the Canadian Air Transport Security Authority (CATSA) which was given responsibility for providing passenger and baggage screening at 89 airports, as well as developing a program for screening airport employees. Transport Canada's role was changed by the 2002 legislation, refocusing it on security policy and regulation, while CATSA provided the aviation security services. CATSA opted to contract with private service providers for those functions at all 89 airports (CATSA Act Review Secretariat 2006).

US aviation security was likewise driven by the changing nature of the threat. Hijackings in the 1960s led the FAA to have airlines install walk-through metal detectors and X-ray machines for carry-on items at selected airports from which hijacked flights had originated. More hijackings in the early 1970s led to an FAA emergency rule requiring airlines to screen all passengers and carry-on bags. This rule was codified into law in 1974. Airports were made responsible for the security of their premises, while airlines were responsible for all passenger screening. Since the latter costs became new airline operating expenses, the airlines had an incentive to keep them as low as possible in the competitive environment following the Airline Deregulation Act of 1978. Hence, airlines outsourced screening to private security companies, at the lowest possible cost.

In response to the Pan Am 103 bombing, Congress ordered the FAA to research and develop an effective explosive detection system for checked baggage, and introduced background checks for new employees and contract personnel with access to secure areas. A subsequent White House Commission on Aviation Safety and Security recommended government funding for aviation security, licensing and performance standards for screening companies, background checks for all screeners and persons with access to secure areas, expanded testing of airport security, and comprehensive passenger-baggage matching (Armstrong & Pereira 2001). Congress also mandated (in 1996) that the FAA 'certify companies providing security screening and improve the training and testing of security screeners through the development of uniform performance standards for providing security screening services'. FAA's proposed rule was never finalised; hence, no such standards were in place by September 11, 2001 (Poole Jr. 2002).

Although none of the deficiencies of the passenger or baggage screening systems was implicated in the 9/11 attackers' success, the poor quality of screening became the main focus of attention as Congress debated legislation to beef up US aviation security. The resulting law 'federalized' airport screening by creating the TSA to carry out expanded passenger and baggage screening using government employees. It mandated 100 per cent screening of all checked bags for explosives by a certain date (which had to be extended by one year) (Brill 2003).

5. Comparison and assessment of current aviation security policies

Who pays for aviation security?

The Canadian system represents the most transparent case. An Air Travelers Security Charge is applied to all airline tickets, and its proceeds fund 100 per cent of the budget for CATSA, which handles airport security and the funding of air marshals. These funds also paid for strengthening the cockpit doors of Canadian airliners and pay for the added numbers Transport Canada security inspectors.

Thus, Canadian policy on transportation security appears to be mode-specific, that is, the costs of protecting a mode of transportation are borne by the users of that mode. (Whether Canada is applying that policy consistently to other modes is beyond the scope of this paper.) Canadian airport and airline trade associations argue that 'aviation security is a "national defence" issue and as such should be funded from general revenues' (Canadian Airports Council 2006). But after making this point, their recommendations (during a five-year review of CATSA in 2006) all focus on making the present funding mechanism more transparent and responsive to changing needs.

In Europe, the pattern varies by country. In the United Kingdom, the major airports (all of which are commercialised, with most now in the private sector) are responsible for all airport security, at their own expense. These costs get factored into the cost base on which they charge airlines for airside and landside services. Germany has a federal aviation security tax which is added to airline tickets, but that tax covers only a portion of the capital and operating costs of airport security, the balance of which are paid for out of airport budgets. Some German airports have been privatised, while others remain owned by some combination of state and municipal governments. Thus, ultimate responsibility for aviation security costs in Europe seems to be a mix of passenger taxes and airport costs, with the latter being absorbed by airline charges. Although this is largely mode-specific, it is less transparently so than in Canada.

The US presents the most complex assortment of funding sources. By 2007 the fraction of TSA's aviation budget that was provided by security taxes on airlines and passenger tickets slightly exceeded 50 per cent. The balance of TSA's funding comes from the federal government's general fund. In addition, airports themselves are responsible for access control and airside security, costs which become part of their cost base and are passed along to airlines via airport rates and charges. Cost estimates for those portions of aviation security expense are not readily available. But because of significant federal general-fund support of TSA's aviation security budget, the US departs significantly from the fully mode-specific funding approach of Canada and the increasingly mode-specific funding approach of EU countries.

There is some merit in the argument that transnational terrorism is a threat to entire societies and therefore that measures taken against it could be considered one component of national defence and hence paid for out of general government revenues (as airline and airport groups generally argue). However, if some components of a society present larger targets to terrorists, there is some justification for deciding that those who make use of that component should bear the costs. In this sense, security expenses can be seen as analogous to insurance. While airlines and airports object to the mode-specific approach, in fact they function as advocates for greater cost-effectiveness in aviation security policy, since they and their

customers must bear the costs. However, the case for mode-specific funding being applied to aviation is only fair (in the sense of not creating distortions in mode-choice for customers) if the same principle is applied to the security costs of other transport modes.

Who provides aviation security?

All OECD members have designated a single national agency to be responsible for aviation security. Those agencies are responsible for making policy decisions about security and for regulating the various entities involved in aviation—airports, airlines, pilots, etc. But which party actually delivers various security functions differs considerably.

Canada is unique in having created a crown corporation to carry out most aviation security functions: passenger and baggage screening, access control, biometric identity cards, etc. In Europe, these functions are usually the responsibility of each airport. The US is unique in having a decidedly mixed system. By law, TSA must carry out passenger and checked-baggage screening at nearly 450 commercial airports, despite TSA also being the national aviation policymaker and regulator. Yet nearly all the remaining airport security functions—access control, perimeter protection, terminal-area policing, etc.—are the responsibility of the airport, under TSA's regulatory oversight. Thus, the TSA combines regulation and service provision within a single entity; a troubling conflict of interest which violates the principle of arm's-length regulation. And TSA's responsibility for providing some but not all airport security functions means divided airport security when unified security and single-point responsibility would be wiser.

One of the largest contrasts in the provision of security functions is the use of private security firms for passenger and baggage screening. Where this function has been devolved from the national policymaker (as in Europe and Canada), the inherent advantages of outsourcing have led to its widespread use. But Congress's over-reaction to the low-performing pre-9/11 airline security contractors led it to mandate a federal government screening workforce, except for a small pilot program under which five airports were permitted to use TSA-regulated private security companies for screening. In theory, after two years of TSA provision at all other airports, those airports could ask TSA to leave and replace them with a TSA-approved security company, selected by TSA and assigned to that airport. Despite better performance by security companies at the five pilot-program airports, no airport has asked TSA to leave (perhaps because TSA is also its security regulator).

An important advantage of outsourcing passenger and baggage screening is flexibility. Thanks to airline start-ups, mergers, and failures (as well as seasonal variations in scheduling), the numbers of emplaned passengers at US airports fluctuate by 10 to 20 per cent per month at most airports, with some smaller airports experiencing much larger monthly changes (Poole Jr. 2006). Yet the TSA's allocation of screeners to airports is done on an *annual* basis, making it difficult to match staffing to workload. Outsourcing facilitates that kind of short-term flexibility, as well as permitting pay scales that match regional differences in living costs.

But the larger, long-term advantage of outsourcing was noted in the RAND Corporation paper on how terrorists adapt to defensive technologies. Over time, terrorists may avoid the technology or alter their operational practices. Five years from now, a 43,000-person civil-service workforce of TSA airport screeners may no longer be appropriate, due either to changes in terrorist methods of operation or to improved technologies. It would be far easier to downsize outsourced screening workforces—and redirect the resources to higher-priority uses—than to reduce the number of civil servants expecting something akin to lifetime tenure.

How risk-based are current security policies?

ICAO's Annex 17 sets forth the minimum aviation security standards expected of all member states (ICAO 2006). Supplementing Annex 17 is the *Security Manual for Safeguarding Civil Aviation Against Acts of Unlawful Interference*, commonly referred to as ICAO Doc 8973. It provides detailed procedures and guidelines on how states may go about implementing the provisions in Annex 17, but it is guidance, not a standard.

Standard 3.1.3 of Annex 17 states that each contracting state 'shall keep under constant review the level of threat to civil aviation within its territory, and establish and implement policies and procedures to adjust relevant elements of its national civil aviation security program, *based on a security risk assessment* carried out by the relevant national authorities' (emphasis added). As interpreted by the Review Panel on CATSA in 2006, this establishes two basic principles for aviation security policy:

- '[I]t must be intelligence-led, based upon up-to-date threat assessments and resilient enough to adapt to new threats as they emerge.
- 'Risk analysis and assessment are the basis for effective use of security resources' (CATSA Act Review Secretariat 2006).

But Annex 17 goes on to provide standards for pre-board screening of passengers and baggage, the quality of screeners and periodic testing of them, passenger-bag reconciliation, cargo security controls, access control via secure identification and random screening, and airport perimeter control. Other Annexes provide for secured cockpit doors, procedures for dealing with disruptive passengers, and air marshals. In other words, there is tension between the implication that various inputs and methods *must be used* and the directive that decisions should derive from risk analysis based on up-to-date intelligence.

Canada's 2006 Advisory Panel review of the CATSA includes a section called 'Risks and Layers: Envisioning Aviation Security'. It cites the ICAO rhetoric and notes that '[Security] resources, financial and human, are not unlimited and should be allocated according to assessed risk' (CATSA Act Review Secretariat 2006). It notes that Canada's Auditor General the previous year had insisted that a risk-based approach is desired and expressed disappointment that Transport Canada 'has not fully implemented formal risk management' (Auditor General of Canada 2005). The Advisory Panel report goes on to say that in its presentations to the Panel, 'CATSA referred to its concept of security screening as risk-based', and that 'Priorities must be established, and these should be based on assessments of the relative level of risk'.

But airports and airlines told the Panel that CATSA should get more serious about a risk-based approach. In passenger screening, it should 'focus on higher-risk passengers, rather than on the objects carried by all passengers'. They also called for better background vetting, so as to streamline the screening that takes place at the airport, 'such as [via] a Registered Traveler Program' (CATSA Act Review Secretariat 2006).

In Europe, Article 4 of EC No. 300/2008 permits member states to 'adopt alternative security measures that provide an adequate level of protection on the basis of a local risk assessment'. By being presented in the context of criteria that would allow states to 'derogate from the common basic standards,' this wording implies that less-stringent protection may be provided if justified by lower levels of risk or certain locations, aircraft sizes, or infrequency of operation.

According to European airport and airline groups, efforts to implement a truly risk-based system are still at an early stage. In October 2006, the Airports Council International Europe (ACI Europe) and the Association of European Airlines (AEA) created a joint effort 'to address shortcomings of the current system'. In its news release announcing the launch of the European Strategic Partnership for Aviation Security (ESPAS), the Director General of ACI Europe said that 'Any new security rule should focus

specifically on the threat or risk that needs to be eliminated, taking account of the impact on passenger mobility and convenience, operations, and cost' (ACI Europe & AEA 2006). However, as of October 2008, the Policy Manager for ACI Europe stated that 'We are still in the early process of a truly risk-assessment-based system in aviation security in the EU' (ACI Europe 2008).

In the US, in 2005, incoming DHS Secretary Michael Chertoff announced a reorganisation of the agency, calling for a more risk-based approach to security. Though praised by DHS's former Inspector General and supported by then new TSA Administrator Kip Hawley, very little had changed by the end of 2008 when the Obama administration took over. In June 2008, the Government Accountability Office (GAO) published a summary of a forum in which 25 experts discussed applying risk management to homeland security (Rabkin 2008). They considered the Coast Guard (but not TSA) to be one of the few federal government agencies that had effectively incorporated risk management principles into its decision-making.

6. Toward a more risk-based approach

Aviation security officials in Canada, Europe and the US have all professed the importance of risk assessment, but thus far there is little evident use of risk assessment to separate cost-effective from non-cost-effective policies. This section suggests how a more risk-based approach to airport security might proceed.

Risk-based passenger and baggage screening

The most important change would be to alter the present *de facto* policy of treating all passengers and bags as needing equal scrutiny. Instead, the system would be based on applying somewhat different procedures to different passengers and their bags, based on an assessment of their relative riskiness.

Three tiers of passengers. The basic premise is that airport screening should identify and isolate dangerous persons, not dangerous objects *per se* (Poole Jr 2006). The challenge is to keep those persons from causing harm, either in the terminal area or to the planes themselves. Terrorists can cause harm in many ways: getting on board with the aim of hijacking, getting on board as a suicide bomber, putting explosives into checked luggage but not boarding, or targeting concentrations of passengers in terminals. Current policies devote most resources to preventing would-be hijackers from boarding with weapons. Yet strengthened and locked cockpit doors (and changed protocols for crew response), have greatly reduced that threat. Far less resources are spent on securing terminal lobby areas and the ramp area where planes park. Thus, current policy downplays the threat of suicide bombers targeting crowds in terminals and the threat of bombs being smuggled onto planes from the ramp.

The proposed risk-based approach would include greater security guard presence in terminals, in ramp areas, and around the airport perimeter. And it requires separating passengers into at least three defined groups, based on the quantity and quality of information about each:

- low-risk passengers, about whom a great deal is known
- high-risk passengers, based either on no knowledge or on specific, negative information
- 'ordinary' passengers, mostly infrequent flyers and leisure travellers.

'Low-risk' passengers are defined as those who possess a government security clearance or are members of a Registered Traveler program (via passing a background check and being issued a biometric identity card). Passengers in this group would go through express lanes at checkpoints, with something like pre-9/11 protocols. As a safeguard and deterrent, a percentage of these people and their bags would be randomly selected for 'ordinary' passenger screening, and this policy would be well-publicised.

'High-risk' passengers include those with no paper trail, about whom so little is known that the safest thing to do is to assume the worst and do a thorough screening of both person and bags. Everyone in this group, in other words, would receive a more rigorous version of today's 'secondary' screening, to include both explosive-detection screening of their carry-ons and either see-through scanning to detect non-metallic objects or a thorough pat-down search. The same protocol would apply to those whose names appear on government-maintained watch lists.

'Ordinary' travellers are those in between the other two categories. These people would receive something like today's level of passenger screening (but with a better-justified list of banned objects). A fraction of this group would be randomly selected for secondary screening, as described above.

Identifying low-risk travellers. The original proposal for a 'trusted traveler' approach appeared in an article published two months after 9/11 (Levine & Golaszewski 2001). The concept was first subject to detailed analytical scrutiny by operations researchers at Carnegie Mellon University in 2003 (Foster et al. 2003). Based on their simulation of its operation at Pittsburgh airport (PIT), 40 per cent of average daily passengers would apply and qualify for the program. Since 40 per cent fewer people would be using the regular lanes, their average processing time would drop from 19.5 to 12.1 minutes. The paper estimated that first-year benefits would exceed first-year costs by $2 million at PIT.

TSA eventually allowed something called a Registered Traveler program to be introduced, but the only background check it carried out was to check applicants against its watch list—the same procedure applied to every air traveller prior to issuance of their boarding pass. This enabled TSA to maintain that Registered Traveler members still required the same level of checkpoint scrutiny as other air travellers. TSA implied that the cost of a 'real' background check would be prohibitive. Yet several million US aviation workers have been subjected to criminal history background checks since 9/11, as a condition of being allowed access to secure areas of the airport on a regular basis. This program is operated by the American Association of Airport Executives (AAAE), in cooperation with the Federal Bureau of Investigation, at a cost of $27 per person (AAAE 2008). At nearly all US airports, such airport workers do not have to pass through metal detectors or have their tools X-rayed when entering secure areas. Thus, a background check that TSA deems sufficient to allow unescorted and unscreened airport workers access to planes is deemed insufficient to allow Registered Traveler members to pass through a streamlined version of checkpoint screening, as envisioned in the original Registered Traveler concept.

Separating ordinary and high-risk passengers. Once low-risk passengers have been self-selected out, the remaining task is to separate high-risk passengers from all the rest. One tool for doing this is a government-maintained watch list, continuously updated, against which all airline passenger reservations would be checked by the national aviation security agency in real time. In the US, such a program is scheduled for implementation in 2009, under the name Secure Flight. In the US until 2009, this was carried out by the airline-operated Computer Assisted Passenger Prescreening System (CAPPS), which dates from pre-9/11 days. Such systems use algorithms to verify the passenger's identity, and then, to look for patterns that might suggest high risk.

To supplement the above tools, and to deal with lobby-area persons not holding tickets (and therefore not passing through the screening checkpoints), a technique called 'behavioral profiling' is being used at Israeli airports (Davis, Pereira & Bulkeley 2002), Boston's Logan Airport, and Las Vegas casinos. The general idea is to unobtrusively monitor people's behaviour, looking for suspicious activities, to be followed up by questioning by security personnel. Many other airports maintain either covert or highly visible law enforcement patrols within airport premises, including lobby areas and airside areas.

Redesigning passenger checkpoints. Security checkpoints for a risk-based system would have two sets of lanes, one set for Registered Travelers and the other set for all others. The proportion of each would have to be varied over time, depending on the fraction of daily originating passengers who were Registered Travelers program members. Space would be required on the approach to the Registered

Travelers lanes for kiosks at which members would insert their biometric identity cards to gain admission to the line for these lanes. On the sterile side of the checkpoint, additional space would be required for secondary screening portals to check the bodies and carry-on bags of selectees for explosives and potential weapons. All high-risk passengers would automatically go through secondary screening. Boarding passes would be coded electronically, not visibly, so that a selectee would not know whether he/she had been selected by an algorithm or at random.

Redesigning checked baggage screening. Neither Canada nor most European countries requires 100 per cent of checked baggage to be scanned by costly EDS machines. But where that mandate applies (as in the US), the risk-based model would reduce the size and cost of checked baggage screening. The bags of Registered Traveler members could be screened via two-dimensional X-ray machines, and would only move on to the more costly screening if a possible problem was detected by the initial X-ray.

RAND Corporation studies of the impact of a Registered Traveler program on the size and cost of EDS installations at large and medium US airports estimated the total cost of various levels of EDS deployment. These studies included the capital and operating costs of the EDS machines and the extra time currently of passengers getting to the airport early enough to ensure that their flight is not delayed due to slow bag processing. Without a Registered Traveler program, the nationwide number of EDS machines was 6,000. But with a Registered Traveler program that required EDS screening of 50 per cent of all bags (all bags of non-Registered Traveler members plus one-sixth of the bags of daily passengers who are Registered Traveler members), the optimal number of EDS machines declined to about 2,500 (Shaver & Kennedy 2004). That's a very large difference in space requirements and in capital and operating costs.

Air cargo security

In sharp contrast to the non-risk-based approach to airport screening followed in Canada, Europe and the US, a risk-based approach to air cargo has been used since 9/11 in these jurisdictions. It parallels the way cargo is dealt with in the maritime system and in cross-border trucking and railroads. It relies on a combination of intelligence information, 'known shippers,' and random screening.

The enormous volumes of cargo and the very high costs in both time delays and equipment that would be required if all cargo had to be physically screened seems to underlie the acceptance of risk-based approaches as a practical reality. Yet when it comes to belly cargo on passenger planes, the inconsistency between the US policy of requiring 100 per cent of all checked baggage to be screened by the most costly equipment (EDS) while belly cargo sitting next to those bags in the cargo hold is largely unscreened has led to calls to close the belly cargo 'loophole.'

In Canada, CATSA originally had no mandate to screen cargo, but in 2006 the government allocated $26 million over two years to design and test an air cargo security initiative, while Transport Canada was developing an Air Cargo Security Strategy in consultation with aviation stakeholders. In Europe, the new EC No 300/2008 calls rather vaguely for member states to determine 'conditions under which cargo and mail shall be screened or subjected to other security controls, as well as the process for the approval or designation of regulated agents, known consigners, and account consigners'.

The struggle between risk-based and 100 per cent physical screening approaches was highlighted in the US when Congress included an air cargo measure based on the latter approach as part of the 9/11 Commission Act of 2007. It calls for TSA to physically screen all belly cargo, with 50 per cent of this to be accomplished by February 2009 and 100 per cent by August 2010. Airlines and airports objected that enforcing such a requirement at airports would be very difficult. Since belly cargo for wide-body planes often arrives on pallets, which are far too large to screen using baggage screening equipment, large new facilities would be required to house costly new equipment. Moreover, the time required to physically

screen all such cargo would disrupt schedules, undercutting the rationale for shipment of high-value, time-sensitive cargo by air.

In response, TSA has developed the Certified Cargo Screening Program (CCSP), which would distribute most of the screening function to various points in the supply chain. Shippers and freight forwarders may opt to become Certified Cargo Screening Facilities, which would screen and seal shipping crates, pallets and/or containers. The sealed boxes would be delivered by them to the airport by certified personnel, to be turned over to the airlines for loading. In effect, this represents an elaboration of the previous 'known shipper' program. Under that program, shippers and freight forwarders who met certain TSA requirements (mostly about supply-chain integrity and control) were deemed to be safe originators of air cargo, whose packages required no more than occasional random screening at the airport, supplemented by periodic vetting of the shippers by TSA inspectors.

An initial 2007 cost estimate from the Congressional Research Service was $3.7 billion over its first 10 years (Elias 2007). In 2008, the Government Accountability Office, using newer information, estimated the total cost of just the equipment at $4.5 billion (Berrick 2008). To that must be added the ongoing costs of staff doing the screening, paperwork, and transportation plus the cost of expanded TSA staff to inspect these 12,000 sites. For context, US belly cargo consists of about 250 million individual packages per year, providing $4.4 billion in airline revenue (Poole Jr 2008).

In October 2008, the US and the EU announced an agreement under which the EU agreed to comply with the US deadlines for belly cargo screening on flights from EU countries to the US (that is, 50 per cent screened by February 2009 and 100 per cent by August 2010). It provides that the EU 'will use the same screening equipment, provide the same training to screeners, and impose the same security requirements on facilities where cargo is screened' (Sullivan 2008).

Thus, recent developments appear to be moving air cargo (at least belly cargo) away from the former risk-based approach and toward the more prescriptive 100 per cent approach applied to passenger and baggage screening. In other words, the discrepancy in policy between belly cargo and checked bags is being resolved by moving away from a truly risk-based approach. This may increase pressure from some quarters to apply similarly costly and non-risk-based approaches to all-cargo planes and later to other modes of shipping.

7. Summary and conclusions

Defending target-rich free societies against terrorism is inherently difficult. On a macro level, it seems unlikely that terrorism can be eliminated in a permanent sense; the inherent asymmetries will likely make free societies attractive targets for one or another terrorist group indefinitely. We also know that terrorists learn from experience, and can change tactics and targets in response to defensive measures. Therefore, defensive measures must be dynamic and flexible, rather than static and predictable.

Most current aviation security programs in Canada, the EU and the US are responses to previous terrorist attacks, rather than more broadly based protections against a range of possible future threats. A number of such programs (for example, air marshals and 100 per cent EDS screening of checked baggage and belly cargo) would likely not pass a test of relative cost-effectiveness, such as the annual cost per life saved. Yet risk assessment, though much talked about as providing a sound basis for setting security priorities and allocating resources, seems to be very difficult to put into practice, despite its potential for getting significantly more value from whatever amount of resources is available in a country for aviation security.

One possible incentive for a more risk-based policy is mode-specific security funding, for example, that the costs of aviation security be paid for by aviation system users. This gives that user group an incentive

to monitor the costs and cost-effectiveness of security programs that affect it, serving to some extent as a counter-weight to politicians' tendencies to impose costly but ineffective programs. In this regard, Canada most closely adheres to this principle in aviation, with the US departing the most from it and Europe in between.

In terms of flexibility, the EU countries have devolved airport security functions most completely to the airport level (under national government regulatory supervision), permitting resources to be tailored to need and, thanks to outsourcing, permitting changes in workforce levels in response to changing threat and demand levels. Canada makes wide use of outsourcing, but in a centralised model that does not take account of regional cost differences. The US is least flexible, with all passenger and baggage screeners (except for a handful employed by highly regulated contract firms) working directly for the federal government. In addition, the US model results in fragmented security responsibility at the airport level, with the TSA providing screening services and the airport providing all other security functions.

Rhetoric in all the countries examined here supports risk-based security, and indeed, that is largely the practice in all forms of goods movement, including air cargo. Perhaps that is because cargo is much less visible to the public, and because the consequences for supply chains would be so great if passenger-type security measures were applied to all goods movement. The GAO's expert panel on strengthening the use of risk management principles was asked to identify the 'key challenges' to doing so (Rabkin 2008). The number one challenge was to 'Educate the public about risks and engage in public discourse to reach consensus on an acceptable level of risk'. Number two was to 'Educate policymakers and establish a common lexicon for discussing risk' to counteract political obstacles to risk-based resource allocation.

The goal should be to wean legislators away from enacting mandates not based on risk analysis. Legislators should direct the national aviation security policymaker/regulator to address problems within some kinds of quantitative parameters (for example, the US Department of Transport's $3 million per life saved measure). Details of making actual policy and resource-allocation decisions should be left to the aviation security agency. That agency, in turn, should be flexible in tailoring policies to changing threats and different situations at individual airports which vary enormously in type, size, configuration, etc.

No security policy should be pursued 'at all costs,' since resources are always limited. Likewise, all possible targets cannot be hardened to any appreciable degree, without bankrupting a country. While it seems likely that commercial aviation will remain a high-profile potential target, spending billions every year on static defences at airports is almost certainly a poor use of resources. Whether any kind of effort can succeed in educating elected legislators and opinion leaders to these realities is the most difficult challenge.

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Robert W Poole, Jr

Robert Poole is Director of Transportation Policy at the Reason Foundation. He received his B.S. and M.S. in engineering from MIT, and worked in aerospace before helping to launch the Foundation in 1978. He has served on federal and state advisory bodies on transportation and is a member of the US Government Accountability Office's National Aviation Studies Advisory Panel.