TANGIBLE AND INTANGIBLE BENEFITS OF SECURITY MEASURES FOR TRANSPORTATION IN CANADA

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Introduction

Focus on the security of transportation networks has increased since the terrorist attack of September 11, 2001 and subsequent attacks in Madrid and London. Transportation networks have characteristics that make them particularly attractive to terrorists. These include:

- Multiple access points;
- Economic importance;
- High visibility; and,
- Public involvement and ownership.

Multiple access points make it difficult to harden the system from a security perspective. Public buses are a favourite target of terrorists because they have so many entry and exit points.

Economic importance makes transportation networks high value targets. Container traffic through the Port of Vancouver is 1.8 million TEUs per year. An attack at this sea port could have a significant deleterious effect on the Canadian economy.

High visibility guarantees that transport disruptions are widely reported. Aircraft disasters receive extensive media coverage whether or not terrorist are involved.

Public involvement and ownership of transportation is pervasive. Infrastructure is mainly publicly owned or quasi publicly owned. Attacks on transit systems, port facilities, and airports allow the terrorists to claim they are striking at “the government”.

The potential for terrorist attack and criminal activity in the transportation network have resulted in range of new risk management programs by governments. Canadian examples include:

- Higher levels of security screening at airports;
- Increased scrutiny of goods and people at land entry points;
- Marshals on aircraft; and
- Funding specific programs designed to reduce transportation risk such as the Transit Secure program.

Enhanced security has increased government spending and the costs of the private sector. Between 2002/03 and 2006/07, the Government of Canada collected $1.97 billion through the Air Travelers Security Charge for increased screening at airports in Canada[2]. Canadian exporters face the costs of advanced notification systems and inspection of goods at ports of exit to the U.S. and tougher entry documentation requirements for persons. The cost of increased wait times for trucking companies at the Canada/U.S. border is estimated to range from $Cdn 179 million to $Cdn 406 million[3].

The cost and effectiveness of transportation security programs is an on-going debate. This paper examines the other side of the cost-benefit equation. The purpose of this analysis is to provide some balance to the discussion of increased transportation security by focusing on the benefits that security measures yield.

The paper begins with some theoretical concepts of risk assessment. Against this backdrop an economic model of social costs and benefits is described. The qualitative assessment of the tangible and intangible benefits of security based on this foundation is presented.

Dimensions of Risk

Risk assessment literature suggests two perspectives of risk assessment:[4] positivistic and contextualist. The first group suggests that risk assessments are quantifiable and the value of an adverse event is determinable. From a statistical perspective, given a large enough pool and relatively frequent events this may be the case. An example would be the “calculation” of the risk of an automobile

being stolen, or the risk of a theft from a business. In this case the severity (S) of the event is relatively small and the frequency (F) relatively large so the expected value of the event (E) is determinable as simply: E = S x F.

A problem with the positivist approach is the estimation of events that are unknown, or with little prior history. An example is assessing the frequency of a comet striking the earth, or the experience of a terrorist attack. In this case the frequency may be undefined or carry a large margin for error. While frequency is extremely low, severity is often extremely large. These events may simply not be measurable in a positivist framework, even though the events do constitute risks.

The contextualist group views risk in terms of normative criteria. In this model, risk assessment is based on socio-psychological factors such as:

- Dread[5]: An amalgam of perceptual factors such as fear, degree of irreversibility, individual controllability, and deferral to future generations.
- Social Context[6]: Factors such as salience for blame, degree of identifiably and benefits of the risk, the risks of mitigation.
- Culture[7]: How ones cultural background affects their perspective towards risk.

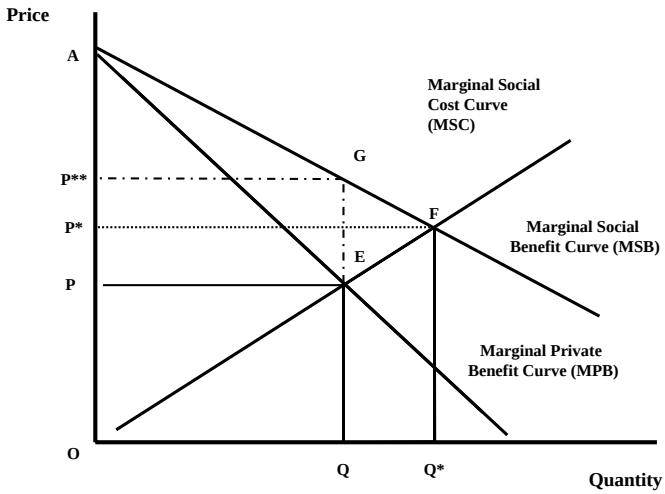
In order to measure the risk in the normative context, one could determine the response of the populace (or a sample thereof) and use that to determine the risk level. If the risk is mitigated through improved security, the benefit of security could then be determined. While it would appear relatively simple to rank risks in this manner, results tend to vary widely within a group.

The importance of the normative factors is through their impact on the demand for security. Tastes and preferences are influenced by changes in normative factors. Consequently, a change in these factors will affect the costs and benefits of security measures in transportation. An example is riding a bus after a terrorist threat. The dread effect may result in change in the security demanded even if the risk of another attack in the same local is highly unlikely.

Economic Model of Security Costs and Benefits

Social benefits of security can be described in terms of marginal social benefits (MSB). Payments for these services are described as marginal social costs (MSC). Figure 1 illustrates this model. The societal optimum occurs where MSB equals MSC[8]. The equilibrium would be established at point F, with quantity Q* and price P*. If the marginal social benefit is greater than the marginal private benefit, consumers would like more security than they can purchase through the commercial market. The social optimum, point F, requires government expenditure to supply quantity Q*- Q of security while the private sector supplies OQ units.

Figure 1

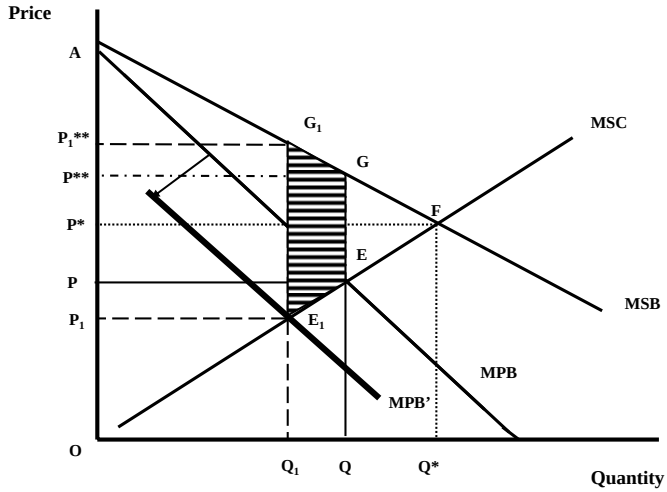


The public benefits cannot be provided in a commercial market because of the "free rider" problem. No user can be excluded if security is provided leaving no incentive for individuals to act collectively. As well the protection of transportation systems may have positive externalities for non-users. For example, Coughlin, Cohen and Khan observe that the benefits of aviation security extend beyond the passengers. "Occupants of high-rise buildings as well as those occupying other potential targets for terrorist acts (e.g. nuclear

power plants and government buildings) can benefit from aviation security and in fact, the benefits can extend beyond those individuals to their families and much further."[9]

Figure 2 shows the consequence of a change in risk due to improved public safety. An example could be the implementation of public surveillance cameras that improves the effectiveness of the police and reduces acts of vandalism at an intercity bus terminal. The result is that tastes and preferences change, which results in the marginal private benefit curve shifting from MPB to MPB'. The new private equilibrium occurs at point E_1, with price P_1 and quantity Q_1. Assuming that this change in risk does not cause a shift in the marginal social benefit curve, the equilibrium socially desirable level of security remains at Q* with price P*. The net welfare gain is the shaded area E_1FG_1 – EFG.

Figure 2

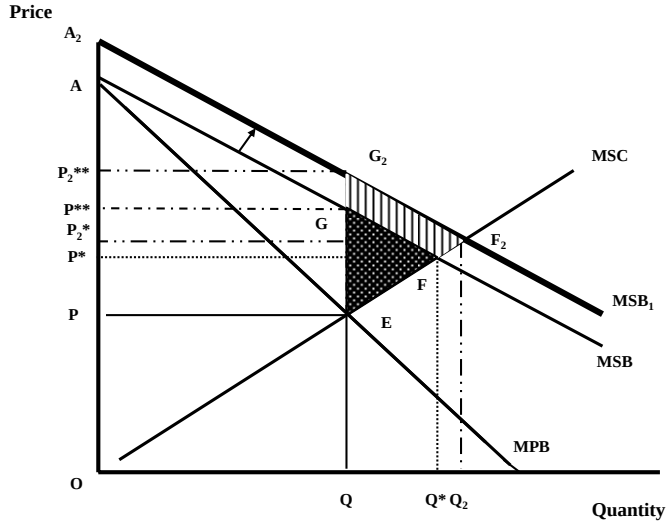


Conversely, the MPB curve shifts in the opposite direction if the level of private risk absorption increases. An example could be a security failure at a terminal, for example an assault.

Suppose an event such as a natural disaster, or terrorist attack occurs. The public demands improved security from the government. In this case, MSB shifts out to the right to MSB_1 as shown in Figure 3. The

socially desirable quantity of security increases from Q* t o Q_2 and the price rises from P* to P_2* and social welfare increases by EF_2G_2 - EFG. The provision of greater security by the government to meet the perceived threat increases economic welfare by the shaded area G_2F_2FG.

Figure 3



It is worth noting that the increased social benefit of increased security is added to the benefit of existing transportation security measures[10]. In the next section we explore the tangible and intangible benefits throughout the economy.

Tangible and Intangible Benefits of Transportation Security

In this analysis security measures are described in four categories:

- Sovereignty protection;
- Terrorism prevention;
- Interdiction of illegal activities; and
- Personal security.

The benefits of the security measures in each category are classified according to the general rule: are the benefits the intended or a side-

effect of the activity, and can the benefits be quantified at market prices? This rule creates four groups. The intended outcomes are the direct benefits, while the positive spillovers of security measures are the inadvertent or indirect benefits. If these direct or indirect benefits can be measured using market prices, they are classified as tangible benefits. If market prices do not exist, then the benefits are considered to be intangible.

Sovereignty protection provides security related to foreign business and goods, financial transactions, communications and travelers. Table 1 shows the benefits of sovereignty protection.

Table 1: Benefits of Sovereignty Protection

	Direct Benefits	**Indirect Benefits**
Tangible Benefits	Compliance of with Canadian regulations Reduction of smuggling and illegal activity Control of foreign disease and pests	Interoperability of the supply chain Expansion of trade
Intangible Benefits	Enhanced sovereignty Fair immigration practice Protection of flora and fauna	Culture of law obedience

Compliance with Canadian border regulations facilitates trade which results in higher levels of growth for business, and ultimately a higher standard of living in the country. Reduction of smuggling and similar illegal economic activity provides benefits to both the government and private sector. Illegally imported goods have the effect of undermining producers within the local economy. For example importation of counterfeit goods may undermine domestic production of high end consumer goods. As domestic producers prosper, so does the government and the public at large through greater tax revenues.

Transportation is a conduit for the introduction of undesirable pests and diseases. Inspections at borders aim to prevent such occurrences that could undermine domestic production or domestic markets.

Sovereignty protection measures have two indirect tangible benefits. The requirement for electronic filing at the Canada/U.S. border

allows disparate members of the supply chain to use similar information. This eliminates inconsistencies and increases productivity. Walton and Maruschek note that "electronic data interchange (EDI) is a technology that can help reduce the cost of supplier co-ordination by improving the ability of the purchasing manager to manage suppliers and by enhancing buyer-supplier relationships"[11] .

Security improvements can promote increased efficiency of cross border traffic. The efficiency impact is large. Wilson, Mann and Otsuki in a study related to the Asia Pacific Economic Cooperation (APEC) countries suggest that improving efficiency at ports where the below average APEC members are brought up to average would increase trade flows in the region by 9.7% , while simply improving the customs environment results in a 1.8% gain[12].

Transportation security enhances sovereignty. The imposition of Canadian security regulations on ships operating in the Northwest Passage strengthens Canada's claim to the waterway and the northern landmass.

Improved sovereignty protection promotes the fair application of immigration policy. Illegal entry mocks the efforts of new immigrants that follow the regulations and the extensive waiting times required to gain lawful immigration.

Better security reduces the likelihood that foreign vessels will knowingly pollute Canadian waters. The social benefit of preserving Canadian flora and fauna does not have a market valuation, short of a tourist benefit, but there is a psychic benefit for citizens who are aware that the environment is not being harmed.

Creating a culture of law obedience is an intangible indirect benefit of sovereignty protection. Canadian society has not become conditioned to black market activity. Once the public views certain regulations and laws as nuisances or irrelevant, an attitude of disrespect for the law can spread to other aspects of the culture.

Threats of espionage and aggression became more diffused with the end of the Cold War. Rather than military secrets, commercial

espionage became the larger target. Rather than preparing for massive military strikes, the threat of aggression shifted to the identification of terrorist cells and the protection of strategic civilian targets. Table 2 summarizes the benefits related to terrorism protection.

Table 2: Benefits Related to Terrorism Prevention		
	Direct Benefits	**Indirect Benefits**
Tangible Benefits	Reduced risk premiums Maintenance of tourism Higher property values	Development of security technology Lower supply chain costs
Intangible Benefits	Open border for U.S. trade Better inter-jurisdictional coordination	Travellers feel safer

Investors require greater risk premiums if terrorist acts threaten their investments. Palac-McMiken[13] suggests at the macro level improved security can result in increased investment and higher levels of GDP.

The tourism industry is another direct beneficiary of anti-terrorism security. If country risk increases tourism decreases. An example is the decline in tourism to Toronto with the sudden acute respiratory syndrome (SARS) outbreak in 2003.

Security measures increase property values for several reasons:

- Personal safety of the owners and employees ensures that people come to work and can be productive;
- Safer facilities attract more and better trained employees;
- Loss of income through disruptions caused by terrorism is reduced; and,
- Consumer loyalty is encouraged by reliability of supply which is a highly desirable attribute of customer service.

Technology that improves security creates tangible indirect benefits. For example, RFIDs that increase throughput speed as a method to limit opportunities for terrorists to infiltrate cargo movements provide the opportunity to lower supply chain costs. As noted by the World Bank "new security protocols being deployed at ports, customs offices, and border posts around the world have the potential to

streamline trade transactions as well as promote safety and security."[14]

Terrorism prevention also has a variety of intangible benefits. A critical benefit for Canada is maintaining trade with the U.S. Trade with the U.S. is responsible for 52 percent of the Canadian GDP[15]. Over $1.8 billion in trade crosses the Canada-U.S. border every day. Although rising oil exports have recently affected the modal shares of transport, in 2001 70 percent of this trade was moved by truck. In that year, more than 13 million trucks and 68.3 million personal vehicles crossed the Canada-U.S. border. The United States accounted for over 80 percent of all export earnings in Canada and provided two-thirds of Canadian imports.

Improved terrorism prevention results in improved inter-jurisdictional co-ordination. Reducing opportunities for terrorist acts improves efficiency and effectiveness. For example, search and rescue efforts can be mobilized faster and draw upon available resources that are closest to the need for help. Similarly, information sharing can help track criminal activity as well as that of suspected terrorists.

The indirect intangible benefit of terrorism prevention is travelers feeling safer. Security is essential for business and tourist travel. Business travel and trade will increase if business people feel safe at their destinations so are willing to travel to take advantage of potential business opportunities. Similarly tourists are unlikely to travel to destinations that they feel are unsafe.

Governments enforce laws and regulations to ensure transportation safety, prevent property damage and to block criminal activities. Illegal activities range from hours of service violations to the distribution of counterfeit aircraft parts and the movement of stolen goods. Table 3 provides the benefits related to the interdiction of illegal activities.

Table 3: Benefits Related to the Interdiction of Illegal Activities		
	Direct Benefits	**Indirect Benefits**
Tangible Benefits	Reduced risk premiums Lower staff costs Crime does not pay so well	Lower supply chain costs
Intangible Benefits	Better inter-jurisdictional coordination	Reduced managerial stress Travellers feel safer Culture of law obedience

Improved inspection, enhanced security of facilities and better monitoring of participants, such as truck drivers, all serve to decrease the frequency and severity of insured losses. The direct tangible benefit is the decrease in insurance premiums charged.

Where conditions are perceived to be insecure and unsafe workers seek higher wages. A current example is the high wages paid to the civilian contractors that are working in Iraq and the oil industry of South America. These extreme cases illustrate the link between security and labour costs. Weak security programs also drive up recruitment and training costs. High turnover rates require a continuous effort to sustain employment levels and weaken morale. Firm lose the benefits of experience and the loyalty of long-term employees, or what is sometimes called the "corporate memory". In short, weak security results in higher production costs.

With better security, less opportunity exists to sell stolen merchandise in the local market, export stolen property to other countries, or engage in money laundering. Interdiction of money laundering has focused controls of financial institutions that transfer funds internationally. As financial controls increase, criminals have turned to trade as a means of transferring illegally gotten funds out of an affected jurisdiction. One method is to overpay for imports, or to undercharge for exports. The partner company sells the goods at the correct value and obtains "clean" money for the criminals. New data mining technology can identify imports and exports with invoice values that are inconsistent with market prices. This is leading to better inter-jurisdictional co-ordination.

The tangible indirect benefit of better interdiction activities is lower supply chain costs due to reduced theft losses and fraud. FIA International Research in a report to the International Cargo Security Council indicated that cargo theft worldwide was $50 billion in 2001 with $25 billion in the United States[16] Even a 10% reduction in theft due to improved security through interdiction would result in a $5 billion per year benefit.

Better interdiction of criminal activity reduces stress for managers who are responsible for supply chain functions. If shipments are interrupted by theft or damage, extra management time must be spent expediting emergency supplies to maintain customer service. Higher staff turnover also increases managerial stress in the recruitment and training of new employees. Uncertainty in general forces management to maintain a higher level of preparedness than would otherwise occur in a more secure environment.

Transportation security also provides benefits to individuals as presented in Table 4.

Table 4: Benefits Related to Personal Security

	Direct Benefits	**Indirect Benefits**
Tangible Benefits	Reduced risk premiums Employment losses, medical expenses, etc. Computer security	Higher asset values
Intangible Benefits	Improved crime prevention Reduced stress and inter-group tension	Transference of fear to real risks

Similar to the commercial supply chain improved security reduces insurance costs for individuals. If a homeowner or small business operator installs an alarm system in their vehicles their insurance premiums decrease. With improved security, insurance may be provided to individuals and businesses that were previously not insurable. Better security reduces the potential for harm to individuals and lowers medical costs and lost productivity during recovery periods.

Computer security is also affected by transportation security. As transportation systems become more dependent on computer based technologies, and requirements for hardening these systems against attack increases, individuals subsequently benefit as the security technologies spill over.

Better security at the individual level, has an indirect benefit of increasing asset values. In a secure environment, individuals and individual businesses are more confident about investing in property improvements and exhibit greater care over their surroundings. Problems like vehicle vandalism, arson and theft can destabilize a neighbourhood and cause some residents to re-locate if petty crimes become chronic.

Taylor et al. prepared a comprehensive analysis of the security of transit and rail systems. The analysis reports that "According to Federal Transit Administration data, an average of 279 people have [sic] been killed on or by public transit each year over the past decade. In addition, an annual average of 18,748 people have been injured on or by public transit over the same period. Crimes ostensibly unrelated to transit use—such as being robbed or killed while waiting at a bus stop—would push these figures far higher[17]." Protection from harassment and assault of this magnitude is a direct intangible transportation security benefit. Taylor et al. suggest that fear of crime is a deterrent to the use of public transit. Consequently, increased security measures could have a positive effect on ridership.

Another tangible benefit of improved transportation security is reduced stress and inter-group tension. People who feel secure about themselves, their families, employees, customers and suppliers feel less stress than people who are worried about their personal security and the security of others. The weaker the security provided, the greater the stress for all individuals in society.

An indirect intangible benefit relates to the differences in how individuals cope with risk. A low tolerance for risk can lead to extreme efforts to avoid perceived danger that are disproportionate to the probability of an incident. An example is hording by individuals as a result of a highly publicized risk event in another part of the country (or world). While individuals should be prepared for potential

adverse events, a more stable and secure environment results in a lower transference of fear.

Summary and Conclusions

The widespread perception of transportation security measures is that costs are significant and measurable, while the benefits of enhancing public security are general and indeterminate. This analysis suggests that the benefits of transportation security measures provide a wide range of benefits to society, businesses and individuals.

Based on positivist and normative concepts of risk this analysis constructs an economic model where social benefits curves react to changes in risk levels. The model outlines the effects of transportation security measures and related welfare impact. Within the broad concept of social welfare, benefits can be classified as tangible and direct, tangible and indirect, intangible and direct, and intangible and indirect.

Few attempts are made to place a quantitative value on the benefits of transportation security measures. Some indications of magnitude are reported, but few specific measures are provided. Direct measurement of security benefits is plagued by the problems of assessing risk and uncertainty and the magnitude of an incident. House insurance is always a waste of money in retrospect, if the homeowner never experiences a claim. Some broader benefits of security cannot be priced because they are social and psychological in nature. These benefits can have an important value to society, but quantification involves subjective measures.

It is tempting to declare that the benefits of security far exceed their cost, but this study is qualitative in nature. Quantification of security benefits is more difficult. In some cases data are not readily available, and no suitable measures exist of a pre and post security state. In some cases however quantification may be possible. We leave challenge of data collection and analysis to others.

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