Benefits of Security Measures on Transportation[1]

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ABSTRACT

Transportation networks are high value targets for terrorists and criminals. They are widely accessible, visible, attract intense media attention and have a significant degree of government ownership. Since the 9/11 terrorist attack in 2001, transportation networks have been the focus of increasing security improvements worldwide.

Much of the analytical work with respect to improved security of transportation networks has been related to the costs of the security improvements. Benefits have largely been ignored or described in general terms of community safety or the risk of terrorism to trade flows.

This analysis provides a qualitative analysis of the benefits of security. An economic framework is used as a guide to develop a taxonomy of security benefits in four dimensions: sovereignty protection, terrorism prevention, interdiction of illegal activities and personal security. Direct and indirect benefits are described. The analysis shows that the benefits of transportation security measures are often more subtle and pervasive than simply providing a safer and more secure community.

INTRODUCTION

Transportation networks are the conduits through which economic activity takes place. This ranges from the simple task of day to day attendance at a job to international trade flowing through seaports. A shut down of transportation facilities can have a significant affect on the economy. For a group wishing to make a significant statement, transportation provides a highly visible platform. Virtually everyone uses transportation in one form or another daily. If making a statement and creating fear are objectives, then the transportation network is an ideal target. Moreover, transportation infrastructure has an important component of public ownership. If a strike at the government is a goal, then an attack of a transportation network also serves this purpose.

Transportation networks are recognized as "soft" targets and security has been increased worldwide. Specific security programs can be categorized into four broad groupings

- Improved inspection,
- Advanced notification,
- Law enforcement, and
- Transportation security funding.

Inspection programs include the screening of air passengers and freight. Baggage and cargo are passed through x-ray detection systems and enhanced documentation is required for goods and persons. Related inspection measures include advanced notification systems. U.S. Customs and Border Protection requires information on the contents of vehicles, trailers and containers prior to arrival at ports of entry. Current regulations require 24 hours notice for ocean container entry and a minimum 1 hour pre-arrival notification for trucks.

Law enforcement runs the range of activities from air marshals on commercial flights to more and better trained officers at all ports of entry. In the U.S., grants are made to non federal organizations to improve transportation security. Examples include the Transit Grant Security Program and support for the Highway Watch Program of the American Trucking Association. In Canada, the government announced the $80 million Transit-Secure program in 2006 to share the costs of increasing security in the rapid transportation systems of the six largest urban centres.

Efforts to increase public security have direct costs to governments and the private sector. Federal, state, civic and foreign governments bear the cost of hardening indigenous targets. The senior levels of governments also bear the cost of ensuring the ability to trade. The U.S Transportation Security Administration indicates that the costs of their air security increased from $1 billion in 2001 to $5.7 billion in 2003[1]. In Australia, $273[2] million in aviation security measures were undertaken in 2002 and 2003. This cost was partially borne by the aviation industry and the Government of Australia.

For the private sector security costs typically fall into increased administration costs, security equipment (fences, cameras, lock passes, etc.) and waiting time. The Congressional Research Service indicated that security spending by the transit sector (rail and passenger bus) was $2 billion from 2001 to 2005[3]. The effect of U.S. border security measures on the Canadian trucking industry has an estimated cost between $Cdn 179 and $Cdn 406 million[4].

There has been substantially less analysis of the benefits arising from transportation security than analyses of the funding and private sector costs. The broad assumption is that the benefits of security are the protection of the public at large and the avoidance of the negative economic consequences. This paper focuses on the benefits of security measures and finds that the benefits are much more pervasive than generally appreciated.

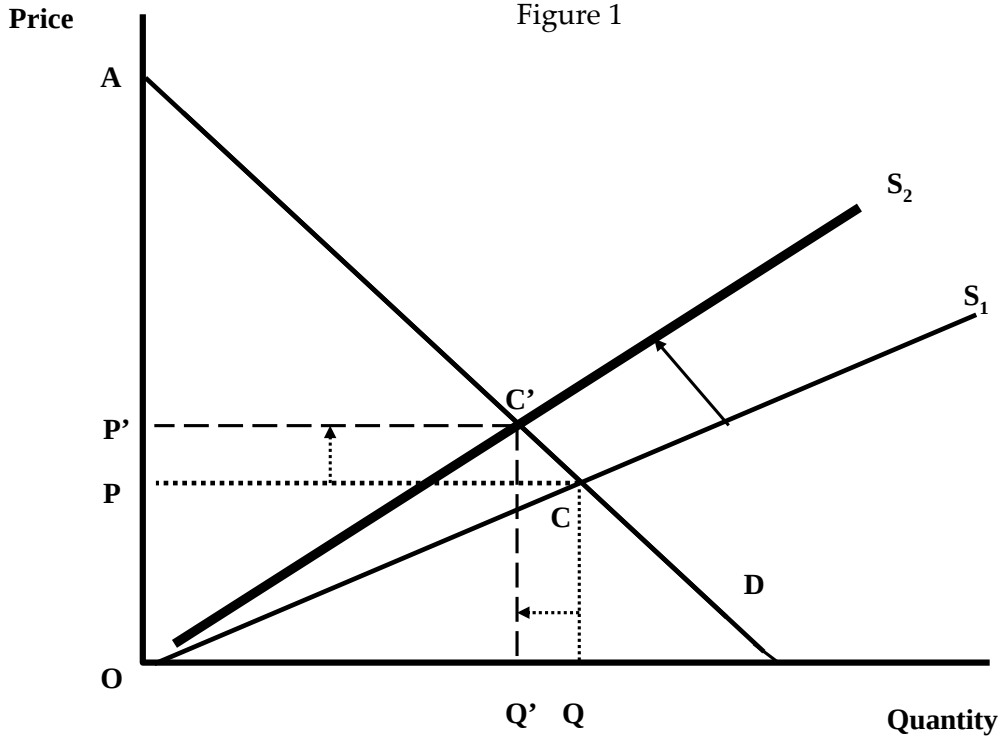
This research is exploratory and provides only a qualitative enumeration of the potential benefits of transportation security. A social welfare framework is used to consider the dimensions of security. The analysis proceeds to describe the direct and indirect benefits of security in the context of the functions performed. In the conclusion some suggestions are offered for extending the study of transportation security measures.

ECONOMIC BACKGROUND

Security is typically provided jointly by the private and public sectors. Individuals and businesses provide for their own security where a market exists. Examples are the provision of private security services at warehouses and vehicle insurance. These types of private security services are supplied by the market according to consumer and producer demand.

Figure 1 shows the situation where transportation security is supplied by the private sector. This could represent a container terminal that pays a private security firm to protect the facility and containers. In this case the supply of security in the port is reflected by the supply curve S_1. Demand for transportation security is reflected in the demand curve, D. In equilibrium, Q units of security are acquired, at a price of P.

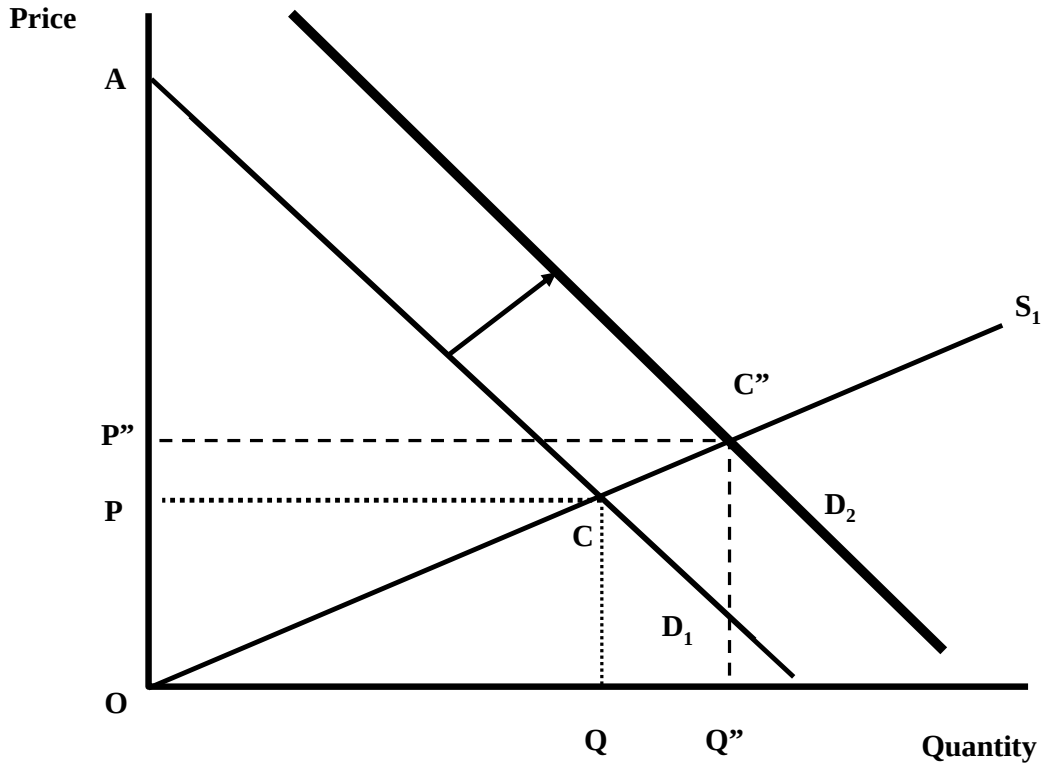
Figure 1



Suppose the government imposes a new security requirement, such as special certification of port area private security personnel. The implication is that the supply curve twists upwards from S_1 to S_2. The level of private security purchased shifts to Q' at a higher price, P'. The consumer surplus changes by ACP-AC'P', while the producer surplus changes by OPC-OP'C'. Consumers lose PCC'P'. Conversely if private security costs decreased, there would be a benefit in the form of a higher consumer surplus. The impact on producer sand suppliers depends on the slope of the supply and demand curves.

A terrorist threat could changes risk attitudes enough to create increased demand for security measures. This could apply to many transport networks, but as an example consider a threat to a rapid transit system. The purchase and installation of new surveillance equipment would be represented by a demand shift. The result is shown in Figure 2. The increased demand raises the price and stimulates an increase in the quantity of security services supplied. Security firms experience a gain in surplus of PCC"P" on an output increase from Q to Q". An increase in consumer surplus also occurs.

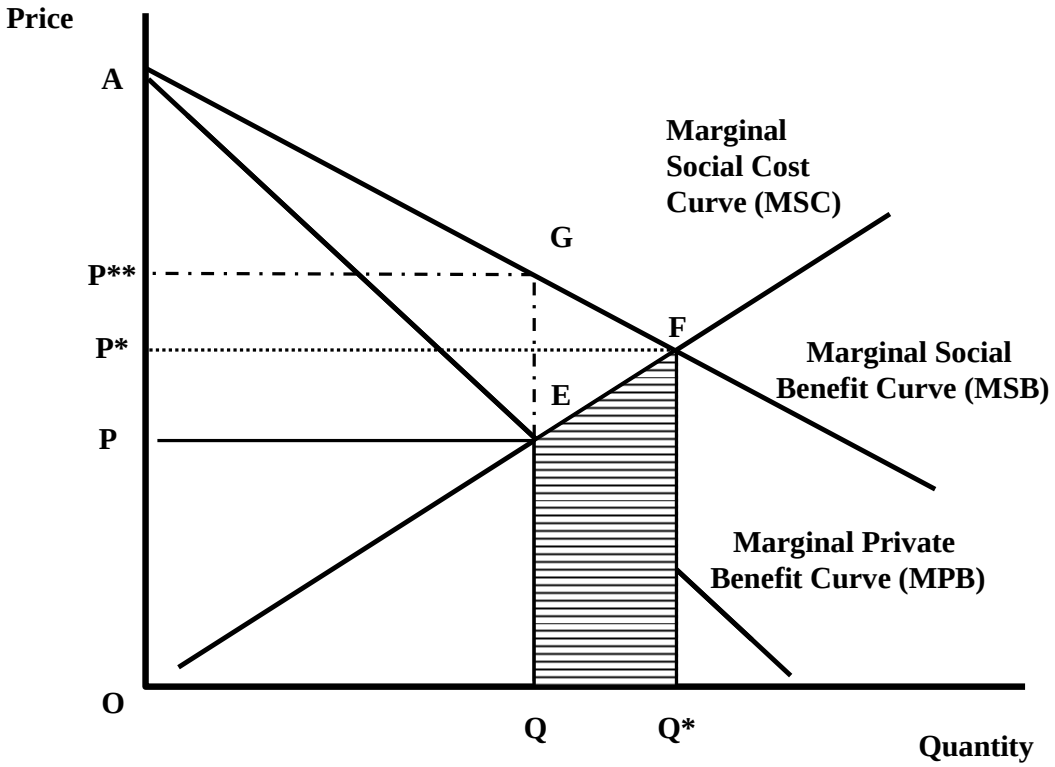
Figure 2



Public security services must be provided by government because well functioning markets do not exist. The demand side of these markets can be expressed in the broader welfare terms of marginal social benefits (MSB). Payments for services and externalities are described as marginal social costs (MSC). 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. Examples are border security and defense.

Figure 3 illustrates the social welfare model. The societal optimum occurs where MSB equals MSC[5]. The equilibrium would be established at point F, with quantity Q* and price P*. The social optimum, point F, requires government expenditure to supply Q*-Q units of security. The allocation of resources to public security is represented by the shaded area EQQ*F

Figure 3

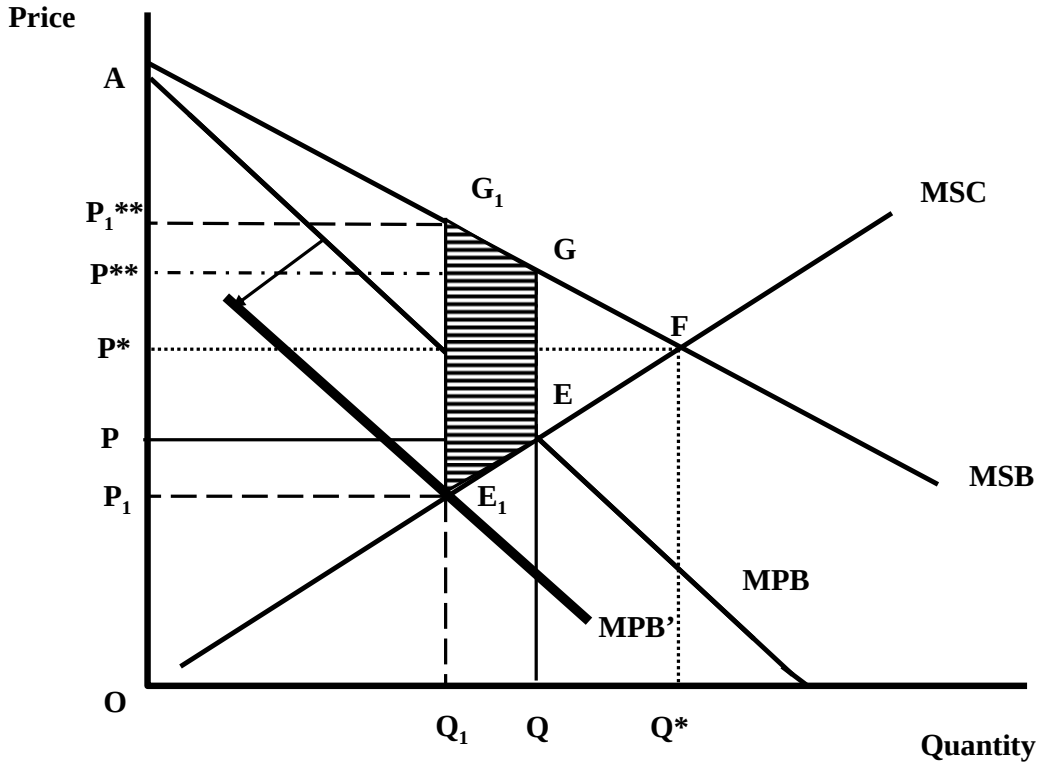


The protection of transportation systems may have positive externalities for non-users. For example, Coughlin, Cohen and Khan observe that the benefits of aviation security extend beyond the passengers. "Occupants of high-rise buildings as well as those occupying other potential targets for terrorist 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."[6]

If the marginal social benefit is greater than the marginal private benefit, consumers would like more security than they can purchase through commercial markets. The deadweight loss of relying only on the private provision of security would be the triangle EFG. This is the area that lies under the marginal social benefits curve and above the marginal private cost curve between the optimal quantity of security services Q* and the private market solution at Q.

Figure 4 shows the consequence of a change in private risk attitudes because of improved public safety. An example could be the implementation of public surveillance cameras to improve the effectiveness of the police and reduce vandalism. In this case reduced risk is assumed on a private basis, 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.

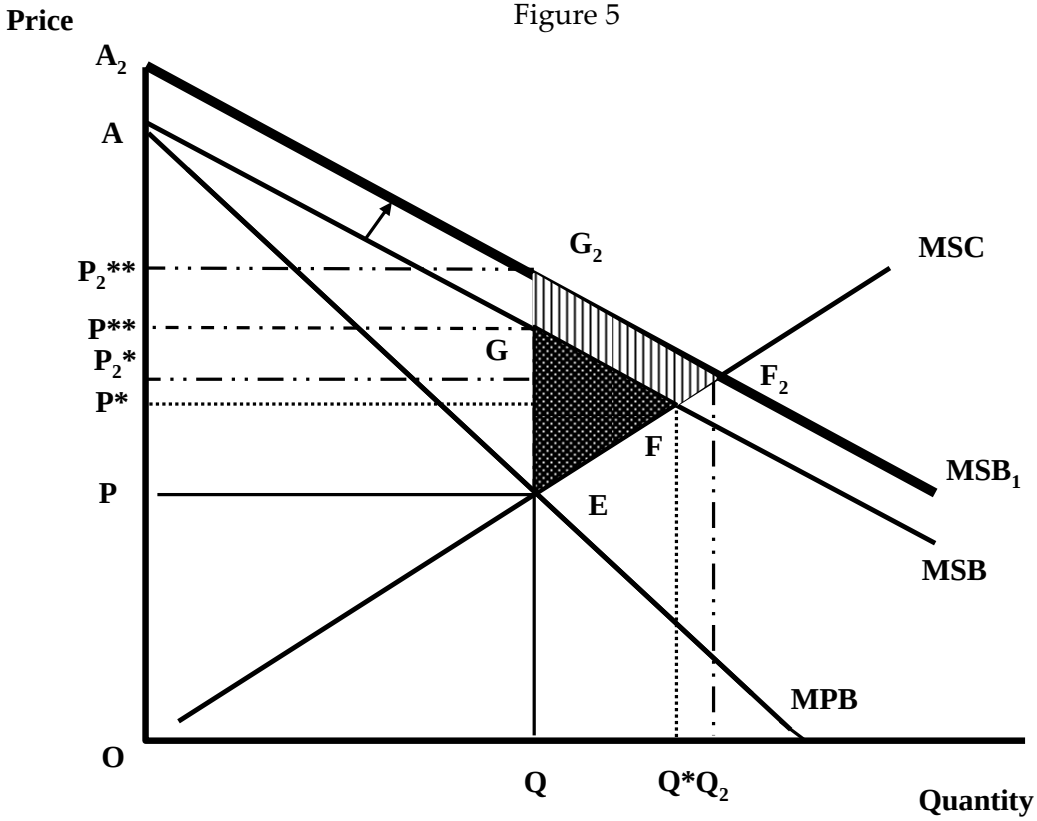
Figure 4



Conversely, the MPB curve could shift in the opposite direction if the level of private risk absorption increases. An example could be a public security failure that makes business more uncertain. The increased cost of insurance for airports and airlines following the 9/11 attack would fit this model.

The level of security demanded from a societal perspective is dynamic. Increased security is likely to be demanded after major disasters or events such as the Asian tsunami or terrorist bombings in Madrid. In this case, MSB shifts out to the right to MSB_1 as shown in Figure 5. The socially desirable quantity of security increases from Q* to Q_2 and the price rises from P* to P_2*. The provision of greater security by the government to meet the perceived threat increases economic welfare by the shaded area G_2F_2FG (EF_2G_2 –EFG).

Figure 5



It is worth noting that the increased social benefit of combating terrorism is added to the existing benefits as represented by the shaded area EFG. New security measures have received most of the attention in the current security literature, but the topic deserves consideration of the broader dimensions of transport security measures[7].

DIMENSIONS OF SECURITY

Four dimensions of transportation security are included in this analysis:

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

Sovereignty protection reflects the concern for security at borders. Regulatory oversight and enforcement is centered on foreign travelers and transporters, imported goods, financial transactions, communications and returning citizens.

The prevention of terrorism and related espionage is not geographically specific. The focus is on the activities of groups acting in either foreign countries or regions of the country.

The interdiction of illegal activities in transport relates to theft, fraud, extortion and other criminal acts.

The provision of personal security is related to individual injury and property damage. Much of what is classified as safety programming, licensing and inspection would be covered as personal security.

Direct and indirect benefits result from these transportation security measures. An example of a direct benefit is the use of radio frequency identification device (RFID) tags on containers as a counter terrorism measure. This has a direct cost and a direct benefit of reducing terrorism risk. In this case there is also has an indirect benefit because the RFID tag allows businesses to better track the location of their goods. Greater inventory visibility improves supply chain response and ultimately customer service.

DIRECT AND INDIRECT BENEFTIS OF TRANSPORTATION SECURITY BY DIMENSION

Sovereignty Protection

Direct benefits: The direct benefits of sovereignty measures include foreign regulatory compliance, reduction of smuggling and illegal entry, and the control of disease and pests infestations from abroad.

Regulatory compliance provides benefits in several ways. Consistent border regulation facilitates trade and spawns higher levels of growth for business. Ultimately, productivity improvements lead to a higher standard of living for citizens. Regulatory compliance also levels the playing field between domestic firms and foreign competitors. For example, compelling foreign vessels or foreign truckers to comply with domestic standards equalizes costs, allowing the domestic industry to operate in a fair competitive market.

Reduction of smuggling and similar illegal economic activity provides benefits to both the government and private sector. Smuggled goods often have a significant tax component, for example, tobacco. Curtailing illegal activity increases government revenues. Illegally imported goods also have the effect of undermining producers within the local economy. For example importation of counterfeit goods may depress domestic prices and production of high end consumer goods.

Transportation is necessary for international trade and tourism but the vehicles used are often 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. Examples are restrictions on imported beef due to cases of BSE or restrictions on fruit and vegetable imports due to concerns over introduction of foreign

mites or other pests. Even packaging material is becoming restricted because pests on pallets have caused infestations.

Indirect Benefits: Indirect benefits of the sovereignty protection and border security include improved functioning of supply chains and expanded trade.

Improved documentation and electronic filing at borders has improved security and commerce. Improved security processes allow disparate members of the supply chain to use similar information. The savings to both supplying and buying firms that use the internet as a basis was observed by Deeter-Shmelz et.al. The indirect benefits of interoperability are significant[8].

With respect to expanded trade, security improvements can promote increased efficiency of cross border traffic. Wasem et.al. provide commentary related to potential efficiency improvements:

> "As part of the Customs-Trade Partnership Against Terrorism (C-TPAT, which is discussed later in this report) and Canada's Partners in Protection programs, the United States and Canada launched a bilateral initiative known as Free and Secure Trade (FAST) to establish complimentary import/export processes. Under FAST, both countries are working to harmonize their inspection and commercial operations at the border. "[9]

The impact of such improvements in efficiency are 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[10].

Terrorism Prevention

Direct Benefits: Anti-terrorism prevention measures result in direct benefits related to higher asset values and maintenance of tourism.

Terrorism prevention reduces risk premiums built into investment decisions, and consequently yields higher asset values. Palac-McMiken[11] suggests at the macro level that improved security can result in increased investment and higher levels of GDP. As well more secure and safer facilities attract better employees, improve productivity and enhance customer service resulting in higher property values.

An additional direct benefit of security related to terrorism is the maintenance of tourism. Tourism is affected by country risk. 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.

Indirect benefits: A number of new technologies and a reduction of waste have resulted from increased terrorism prevention. Key amongst these is the development of improved security screening. Examples of these technologies include: RFIDs, improved radiation/chemical detection sensors and cargo x-raying equipment. These approaches decrease material handling time which is consistent with the goal of improved security. Increased throughput speed reduces opportunities for terrorists to infiltrate cargo movements.

Improved throughput lowers supply chain costs. "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."[12] One example of this possibility is provided by Chabrow[13]. After introducing an electronic supply chain and logistics system, a US manufacturer with annual sales of US $1.2 billion and imports of US $100 million now takes only 20 minutes with half as many people to produce a manifest that formerly took two to three days to prepare.

Interdiction of Illegal Activities

Direct benefits: Interdiction of illegal activities provides direct benefits related to lower insurance risk premiums, lower employee turnover and lower crime rates.

With improved levels of security, risk of loss decreases, and consequently insurance companies charge lower premiums. With respect to global supply chains, 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 consequence is a direct decrease in insurance premiums charged.

Better security improves safety of the working environment, whether it is in an office, on the factory floor, or at a port of entry. Where conditions are perceived to be insecure and unsafe, workers will either seek higher wages, leave, or involve regulatory authorities. Each of these potential actions results in higher costs of production.

With better security, criminal activity should decrease. There is reduced opportunity to sell stolen merchandise in the local market or to export stolen property to other countries. Further, improved controls on money laundering are possible due to improved transportation security. The focus of money laundering interdiction has been controls on the financial institutions that transfer funds internationally. As financial controls have made it more difficult for criminals, they have sought new methods for moving large sums of illegally gotten funds out of the affected jurisdiction. One of these methods is to overpay for imports, or to undercharge for exports. The partner company

then sells the goods at the correct value and obtains "clean" money for the criminals. With the increased tracking of international goods movements, authorities can use data mining technology to identify imports and exports that have invoice values that are inconsistent with market prices.

Indirect Benefits: The primary indirect benefit of better interdiction activities is lower supply chain costs due to reduced theft losses and fraud. Theft and fraud is not a small cost for supply chains. 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[14] Even a 10% reduction in theft due to improved security through interdiction would result in a $5 billion per year benefit.

Personal Security

Direct benefits: Greater security also provides important benefits to individuals. Similar to supply chains as a whole, improved security reduces insurance costs for individuals. The effect is two fold. As individuals improve their security and risks imposed on individuals by others are decreased due to better security, a corresponding decrease will occur in insurance premiums. For example if a homeowner or small business operator installs an alarm system in their vehicles premiums decrease. The second aspect relates to insurance availability. With improved security, insurance may be provided to individuals and businesses that were previously not insurable.

A second direct affect of improved transportation security in the individual security context is a reduction in medical costs. Better security reduces the potential harm related to acts perpetrated on the individual. Costs related to direct medical treatment and potential post event psychological effects are reduced. For businesses the consequent reduction in medical costs limits the rate of increase in company medical costs improving competitiveness and profitability.

Indirect Benefits: 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 vandalism, arson and theft can destabilize a neighbourhood and cause some residents to re-locate if petty crimes become chronic.

Indirectly computer security is also affected by greater 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.

SUMMARY AND CONCLUSIONS

Transportation security measures provide a wide range of benefits that are often hidden due to the broad view being taken. Depending on the dimension considered direct benefits can be measured in higher asset values, lower medical costs or an overall higher standard of living. In addition to these direct benefits there are important indirect benefits that accrue to transportation security. These also vary by the dimension of security considered and are as diverse as improved supply chain performance, lower insurance risk premiums and better vehicle utilization.

This article identifies the benefits of security measures where benefits are tangible. Additional benefits from transportation security are intangible in nature. No market prices exist to measure benefits such as travelers feeling safer, inter-jurisdictional co-operation and reduced personal stress. Expansion of the benefit analysis into these intangibles will be the subject of future papers.

Quantification of the benefits of security is a difficult but not impossible task. Information to quantify the benefits of security measures may not be directly determinable. For example, accurate measurement of the benefits of reduced individual medical costs is likely insurmountable. Data are not readily available, nor is there a suitable measure of the pre and post security state. In some cases, a degree of quantification is possible because the data may be collectable or already exists. An example is the change in time for containers to move through a port due to improved security. This is an interesting field of academic research that is certain to attract increasing attention.

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[5] In this model for simplicity it has been assumed that social marginal costs equal private marginal costs.
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[7] The total benefits are the sum of EFG and G_2F_2FG.
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