Measuring the Economic Costs of Terrorism

Walter Enders

and

Eric Olson

Department of Economics Finance and Legal Studies
Culverhouse College of Commerce & Business Administration
University of Alabama
Tuscaloosa, AL 35487-0024

Abstract

The paper surveys the various economic costs associated with terrorism. Particularly important is the distinction between the direct and the indirect costs. While many terrorist attacks cause substantial amounts of property damage and create casualties, most of the costs associated with terrorism involve the indirect costs. Although terrorism can reduce a nation's overall growth rate, the costs of terrorism are concentrated in a few key sectors. In particular, the transportation and tourism sectors, the financial markets, and the amount of foreign direct investment in a country are especially responsive to terrorist attacks. The costs of possible chemical, biological, radiological, and nuclear (CBRN) attacks are difficult to estimate precisely. However, some attack modes are more likely than others. A radiological attack in New York City could have direct costs of roughly the same magnitude as the 9/11 attacks.

1. Introduction

A necessary precondition for an accurate analysis of the economic costs of terrorism is to carefully differentiate terrorism from other types of crime and from other types of conflict. Since terrorism is a crime that is difficult to define, it is instructive to compare two widely-used definitions in regard to their characterization of the motive, perpetrator, and victim of a terrorist act. The United Nation's 1999 International Convention for the Suppression of the Financing of Terrorism makes reference to any:[1]

> "… act intended to cause death or serious bodily injury to a civilian, or to any other person not taking an active part in the hostilities in a situation of armed conflict, when the purpose of such act, by its nature or context, is to intimidate a population, or to compel a government or an international organisation to do or abstain from doing any act".

By way of comparison, Title 22 of the United States Code, Section 2656f(d) defines terrorism as:[2]

> "Premeditated, politically motivated violence perpetrated against noncombatant targets by subnational groups or clandestine agents, usually intended to influence an audience."

Both definitions clearly indicate that the victim of terrorism is necessarily a noncombatant. Actions against combatants are acts of war, not acts of terrorism. As such, the explosion of an improvised explosive device (IED) targeted for U.S. combat soldiers in Iraq is not a terrorist event. Nevertheless, there is a degree of ambiguity when peacekeepers and passive military targets are the intended victims of an attack.

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[1] For a discussion of the issues surrounding the difficulties faced by the U.N. in arriving at a formal definition of terrorism see http://www.un.org/News/Press/docs/2009/l3145.doc.htm and www.un.org/News/Press/docs/2005/gal3276.doc.htm.

[2] A discussion of the U.S. definition can be found at www.nctc.gov/site/other/definitions.htm. The U.K. definition is available at: www.homeoffice.gov.uk/documents/carlile-terrorism-definition?view=Binary

There must also be a political or social motive for a crime to be defined as terrorism. Even though 32 people were killed in the April 16, 2007 massacre at Virginia Tech University, the shooter, Seung-Hui Cho, was not a terrorist because he had no political motive. Both definitions of terrorism also indicate that the motives of a terrorist involve the intimidation of an audience wider than the immediate victim(s). Even though the Palestinian-born Sirhan Bishara Sirhan declared that he killed Robert Kennedy because of the U.S. stance in the Middle East, many regard him as an assassin, but not a terrorist, because he did not attempt to influence a wide audience. In contrast, Anwar Sadat's assassin, Khalid Islambouli, was clearly a terrorist because his act was designed to have worldwide consequences.

The U.S. definition indicates that the perpetrator of a terrorist act must be a subnational group or clandestine agent. In contrast, the U.N. definition makes no mention of the perpetrator so that it allows some actions undertaken by government entities to be regarded as terrorism. Consider the November 8, 2008 artillery attack by the Israeli Defense Force (IDF) against Gaza that killed 23 Palestinian civilians and injured 40 others. Human Rights Watch reports there is no evidence of any combatant casualties resulting from the artillery shells fired into civilian areas.[3] Thus, someone adhering to the United Nations' definition of terrorism could classify this act as terrorism even though the IDF attack occurred in response to several thousand Qassam rockets having been fired into Israel. Similarly, since civilians were targeted, the WWII firebombing of Dresden, Germany and atomic bombs dropped on Japan could also be classified as terrorism. We cannot hope to settle such disagreements here. As such, we use the term state-

[3] The information concerning the hostilities in Gaza can be found in "Indiscriminate Fire" at the Human Rights Watch website http://www.hrw.org/en/node/10911/section/3.

terrorism or state-sponsored terrorism to refer to circumstances in which governments are involved in the planning, funding, or execution of an action. The term terrorism, then, refers to actions in which the perpetuator is a subnational group. Terrorism is transnational when an incident in one country involves perpetrators, victims, institutions, governments, or citizens of another country.

Notice that civil wars, revolutions, insurgencies, and other forms of political violence may include terrorism as a tactic although this need not be the case. Thus, the cost of terrorism is only a portion of the overall cost of conflict. Since the definition has a number of ambiguities, we should maintain a healthy skepticism of any high-precision measure of the cost of terrorism. Also, it is especially important that a consistent definition be used when trying to measure the costs of terrorism over time or across countries. For example, a merged data set collected from different sources is likely to be fraught with inconsistencies. Similarly, if a single source does not use a consistent definition over time, any dynamic measure of the cost of terrorism is problematic. Nevertheless, with a proper definition, it is possible to obtain a relative measure of the cost of terrorism over time and/or across different geographic areas.

This paper has four purposes. First, the paper surveys the relevant literature and evaluates the methodology and economic consequences of terrorism. Second, the distinction between direct and indirect economic costs of terrorism is highlighted. Third, we differentiate between macroeconomic and microeconomic consequences of terrorism and examine their consequences across different economies. Fourth, the costs of possible chemical, biological, radiological, and nuclear (CBRN) attacks are considered. The remainder of this paper is organized as follows. Section 2 examines the trends in domestic and transnational terrorist data. In Section 3, we differentiate between the direct and indirect costs associated with terrorist attacks, specifically

that of 9/11. Section 4 reviews the sectoral losses associated with terrorist attacks. Section 5, examines the loss of economic growth due to terrorism. In sections 6 and 7 we report the cost of terrorist attacks in terms of human lives and loss in quality of life. Section 8 emphasizes the macroeconomic indirect costs due to attacks. Section 9 reports anticipated costs that would result from a CBRN attack and section 10 concludes.

2. Preliminaries

Figure 1 displays time-series plots of several types of transnational terrorist incidents constructed using data from the Memorial Institute for the Prevention of Terrorism (MIPT) website as described in Enders, Liu and Prodan (2009). Panel 1 shows the annual total of all incidents (ALL) along with the number of bombing incidents (BOMBINGS). Panel 2 shows the annual totals of the sum of all hostage takings and assassinations. Panel 3 shows armed attacks and Panel 4 shows the number of fatalities (not the number of incidents with fatalities). Note that the number of fatalities for 2001 was 3399. This figure is not shown in the graph since the number of fatalities from 9/11 clearly dominates all other entries in the graph.

[Insert Figure 1 here]

From Panel 1, it is clear that ALL steadily rises through the late 1970s, jumps to around 375 incidents per year, and begins a steady decline in the early 1990s. After a low in 1999, the series again rises sharply. Hoffman (2006) and Enders and Sandler (2006) detail the reasons for the overall shape of this time path. Before the 1979 takeover of the U.S. embassy Tehran, the motivation of transnational terrorism was primarily nationalism, separatism, Marxist ideology, and nihilism. The jump in the number of incidents in the early 1980s corresponds to the rise of religious-based fundamentalism. The downward trend in the early 1990s is attributed to the

demise of the Soviet Union and a fall in the number of state-sponsors of terrorism. A surge in religious fervor and the hostilities in Iraq and Afghanistan account for the current high levels of transnational terrorism.

The subcategories—bombings, hostage takings plus assassinations, and armed attacks—all have the same general shape. However, bombings are the tactic of choice by terrorists; at times, bombings account for about two-thirds of all attacks. For a terrorist, bombings have the highest cost/benefit ratio of any type of attack. Bombs, such as IEDs, are generally low cost, garner extensive media coverage, cause large economic losses, and can lead to extensive loss in human life.

Enders and Sandler (2000) first documented the fact that the typical transnational terrorist incident has become more deadly over time. In the MIPT data shown in Panels 1 and 4, once 9/11 is excluded, the 1968Q2 – 1979Q4 period averaged 32 fatalities resulting from 50 incidents per quarter. In the 1980Q1 – 2000Q4 period, the average number of fatalities rose to 81 fatalities per quarter while the average number of events increased to 72. From 2002Q1 – 2006Q4, the average number of fatalities rose to 150 from 81 per quarter while the average number of terrorist attacks increased by only 3. It is especially interesting that most of the fatalities since 1990 have generally been civilians, not political leaders or protected targets. Brandt and Sandler (2010) find that the hardening of military facilities and government facilities has led to a greater targeting of civilians. An especially relevant implication is that there is no simple relationship between the cost of terrorism and the number of incidents. As terrorist acts have become more lethal, the cost per incident has been rising.

The annual totals of all terrorist incidents (domestic and transnational) are shown in Figure 2.[4] Although it is risky to compare different data sets, it is clear that the implied number of domestic incidents shown in Figure 2 far exceeds the number of transnational incidents shown in Figure 1. Nevertheless, it is likely that the host country's' cost of the typical transnational incident far exceeds that of a purely domestic incident. In an attempt to maximize the damage resulting from their attacks, terrorists often target foreign tourists or foreign firms. Foreign firms can usually find alternative host nations for their foreign direct investments and tourists can always find new areas to explore. The targets of domestic terrorism usually have fewer substitution possibilities. Transnational incidents also entail negative transboundary externalities. Even though relatively few transnational attacks occur on U.S. soil, Enders and Sandler (2006) report that approximately half of all transnational attacks involve U.S. targets or have one or more U.S. victims. Thus, an attack in one part of the world often involves the government and the citizenship in a nation thousands of miles distant.

[Insert Figure 2 here]

3. Direct versus Indirect Costs

The direct costs of terrorism include the value of tangibles damaged or destroyed such as factories, equipment, housing and structures, and merchandise. Since economic activity can be disrupted, lost wages and other forms of income are also part of the direct costs of terrorism. Although they are far more difficult to measure, pain and suffering and the value of human lives lost should also be included. Consider the direct costs of the 9/11 attacks reported in the *Survey*

[4] The data in Figure 2 were constructed from the CD ROM of the Global Terrorism Database (GTD). A description of the data set is available at http://www.start.umd.edu/gtd/about/History.aspx.

of Current Business (2001). Private property destruction (including the value of the downed four airplanes) was $14.0 billion and government entities lost $2.2 billion. Wages and salaries lost as a result of the work stoppage were $3.3 billion. However, according the *Survey*, certain government workers earned an additional $0.8 billion overtime payments as a result of the 9/11 attacks. As such, the overall level of wages and salaries is reported to have fallen by $2.5 billion. Clean-up costs were estimated at $10 billion.

Table 1: Estimates of the Direct Costs of 9/11

Structures and equipment		
Private businesses		$ 14.0 billion
State and local government		1.5 billion
Federal government		0.7 billion
Clean-up costs		10.0 billion.
Wages and Salaries		$ 2.5 billion
Private sector employees	$3.3 billion	
Government employees	0.8 billion	
	(net increase)	

In a recent memorandum, the U.S. Department of Transportation (2005) suggests that $5.8 million is the appropriate statistical value of a human life. If we use this measure, the economic value of the lives lost by the non-hijackers was: $17.2 billion [= (2,993 – 19)* $5.8 million]. Thus, excluding any costs for the pain and suffering of those injured in the attacks, a reasonable estimate of these direct costs of 9/11 is $45.9 billion.

Even though the economy was in recession, the unemployment rate increased dramatically after 9/11. The Bureau of Labor Statistics (2003) reports 145,000 workers were laid off as a direct result of the attacks. Navarro and Spencer (2001) calculate a total output loss of $47 billion. Kunreuther et al. (2003) include the lost income from business disruptions and report that the total direct losses of 9/11 were $80 – $90 billion. We do not want to include the cost of

rebuilding the World Trade Center since this would be double-counting. In the same vein, we do not want to include insurance company losses since they are payments designed to cover the direct losses. Nevertheless, there are many indirect costs that have resulted from the attacks. It is the indirect costs of the attack that are most difficult to measure. Of course, these losses were not distributed equally across sectors; the travel and tourism industry was hit especially hard. Ito and Lee (2004) estimate that the demand for air travel declined by more than 30% as a result of the attacks. The inability of heightened airline security personnel to readily process travelers lead to another 7.4% decline in airline demand. Overall, passenger fares declined by $1.5 billion. Navarro and Spencer (2001) calculated the capitalized value of stocks traded on the New York, NASDAQ, and American stock exchanges pre and post-9/11. They found that the total values of market shares declined by $1.7 trillion. Nevertheless, we need to be cautious about interpreting this figure since markets rebounded rather quickly.

Other indirect costs of 9/11 might include the pain and suffering of the victims and their relatives as well as the psychological trauma experienced by a stunned nation. Yet, measuring the full cost of 9/11 becomes problematic because it is particularly difficult to know where to "draw the line." For instance, the Institute for Global Security Analysis estimates that the cost of 9/11 exceeds $100 billion because they include $40 billion for: "Federal emergency funds (heightened airport security, sky marshals, government takeover of airport security, retrofitting aircraft with anti-terrorist devices, cost of operations in Afghanistan)." Since these expenditures are designed to protect against future attacks, it is not clear that they should be fully attributed to 9/11 itself. Instead, they might be better attributed to the overall cost of the "War on Terrorism."

4. Sectoral Responses to Terrorism

The empirical literature indicates that the ability of a nation to weather a terrorist attack is

usually more dependent on the nature of its economic and political system than on the nature of the attack itself. The sustainability of the terrorism campaign as well as the size, openness, and market orientation of the economy all play important roles.

a. Sustainability of Terrorist Campaigns: Shapiro (2004) and Becker and Murphy (2001) make the point that there is an important difference between large scale terrorist events and natural disasters. Terrorists try to extract concessions by creating a general atmosphere of fear and intimidation. Isolated natural disasters and one-time terrorist attacks are viewed as short-term threats. In contrast, individuals in regions with persistent levels of terrorism--such as Israel, Colombia, Kashmir, and the Basque region—come to expect future terrorist events. As such, they use resources to secure themselves and their property against future attacks. These homeland security costs, along with higher than normal risk premiums, act as a long-term tax on economic activity.

Abadie and Gardeazabal (2003) measured the effects of ETA's (Basque Fatherland and Liberty) 25-year campaign to achieve regional autonomy. In their view, the sustained level of terrorism in the Basque region should manifest itself in a higher risk premium that results in a reduced level of capital formation. To test their hypothesis, they constructed a counterfactual Basque region by weighing key performance measures in other regions of Spain. The simulated region acts as a "control" with precisely the same values of real per capita GDP, the investment share of GDP, population density, and human capital measures as those in the Basque region prior to the onset of terrorism. The important finding is that for the 1976 – 1996 period, real per capita GDP in the control region exceeded that of the Basque region by about 10%. The differential was as large as 12% during some high-terrorism periods and as small as 8% in some low-terrorism periods. Abadie and Gardeazabal (2003) also compared the rates of return from

two different stock portfolios. The common stock of companies with sizable business dealings in the Basque region increased by 10.14% after a cease-fire was announced by ETA in late 1998. When the cease-fire collapsed 14 months later, the same portfolio fell by 11.21%. A control portfolio of companies with few ties to the Basque region did not respond to the same announcements.

b. Size of the economy: Policymakers in large economics have the ability to use macroeconomic policy tools to offset the effects of large scale terror attacks. Enders and Sandler (2006) document how the U.S. monetary and fiscal authorities were able to act in concert to offset the macroeconomic consequences of the 9/11 attacks. In response to a surge in the private sector's demand for liquidity, the Federal Reserve cut short-term interest rates dramatically and, on September 12, increased its short-term lending (discounts and repurchases) from a daily average of $24 billion to $61 billion. A $40 billion emergency spending package for airport security and search and rescue efforts at the four crash sites provided a strong fiscal stimulus. Operation Enduring Freedom launched the invasion of Afghanistan on October 7, 2001 and further augmented aggregate demand. In contrast, many governments in small economics do not have the ability to conduct countercyclical monetary or fiscal policy. In developing countries, central banks do not have ready access to international capital markets and the fiscal authorities cannot redirect already strained expenditure levels.

As pointed out by Sandler and Enders (2008), there is also a scale effect in that any given level of damage will have a more pronounced effect in a small country than in a large one. Moreover, large economies tend to be more diversified than small economies. For example, a terrorist campaign targeting tourists could be devastating to a small nation with a large share of tourism in its GDP. In contract, U.S. tourism revenues rebounded quickly following 9/11.

c. Openness: The literature has shown that countries that are heavily reliant on international commerce, particularly tourism, trade and foreign direct investment, are most vulnerable to terrorism.

Enders and Sandler (1991) estimated a vector autoregression (VAR) using monthly Spanish tourism and transnational terrorism data for the 1970 – 1991 period. During this period, the ETA (Basque Fatherland and Liberty) and its splinter groups specifically targeted tourist hotels and U.S. business enterprise located in Spain. If we abstract from the deterministic regressors, it is possible to write their 2-variable VAR as:

$$N_t = A_{11}(L)N_{t-1} + A_{12}(L)T_{t-1} + e_{1t} \quad (1)$$

$$T_t = A_{21}(L)N_{t-1} + A_{22}(L)T_{t-1} + e_{2t} \quad (2)$$

where N_t is the number of tourists visiting Spain; T_t is the number of transnational terrorist incidents in Spain; t is a time subscript; the $A_{ij}(L)$ are polynomials in the lag operator L; and the e_{it} are serially uncorrelated disturbance terms such that $E(e_{1t}e_{2t})$ is not necessarily zero.

Enders and Sandler (1991) found that it was necessary to include 12-monthly lags in the VAR suggesting that it takes at least a full year for tourism to respond to terrorism. Moreover, the level of tourism had little explanatory power in the terrorism equation. This is consistent with the notion that terrorists do not respond to short-term fluctuations in the level of tourism. Allowing for all of the dynamic adjustments that occur within a 36 month period, a typical transnational terrorist incident in Spain decreases the number of foreign visits by 140,847 people. Since there were 41 terrorist attacks explicitly targeting tourists, the estimated total loss is 5,774,727 tourist visits. Since 5,392,000 tourists visited Spain in 1988, the total loss over 22 years was approximately one year's worth of tourism.

These results have been extended in a number of important ways. Since there is little

feedback from tourism to terrorism, a number of researchers have estimated equation (1) as a parsimonious transfer function that explicitly includes the contemporaneous level of terrorism. Enders, Sandler and Parise (1992) calculated that the terrorism cost for Austria, Italy, Greece and continental Europe as a whole was 40.7%, 6.0%, 23.4%, and 29.6% of a year's worth of tourism revenues, respectively. They were not able to find any significant losses for France and Germany.[5] Drakos and Kutan (2003) allow for spillover effects in that terrorism in one country is allowed to affect tourism in another. For our purposes, the interesting result is that Greece, Turkey and Israel all experience significant tourism losses from terrorism; the magnitude of the losses is similar to that of Enders and Sandler (1991). In contrast, Sloboda (2003) estimates a transfer function for the U.S. and finds that terrorism since the first Gulf War cost the U.S. only $56 million in tourism revenues.

The consistent finding across all of these papers is that large countries experience only small tourism losses from terrorism. The losses are much larger (usually in the neighborhood of 5%) for small developed nations with high and sustained levels of terrorism.

Nitsch and Schumacher (2004) use a gravity model to evaluate the impact of terrorism on trade between more than 200 countries from 1968–1979. They report that countries targeted by terrorism trade substantially less with each other than countries that are not targeted. The key finding is that the effect of terrorism on trade is small, but statistically significant: a hypothetical doubling of the number of terrorist incidents would act to decrease bilateral trade flows by 4%. In an updated study, Blomberg and Hess (2006) find similar results using a gravity model and data from 177 countries over 1968–1999 period. They report that the presence of terrorism is

[5] The relatively terror-free nations of Netherlands, Norway and Switzerland showed no significant revenue losses.

associated with a 5.1% decline in bilateral trade. However, the presence of terrorism together with internal and external conflict has a tariff equivalence of 30% on trade. This magnitude is larger than tariff-equivalent costs of border and language barriers.

There is also a large literature on the effects of terrorism on foreign direct investment (FDI). Enders and Sandler (1996) estimate transfer functions and find that terrorism reduces net FDI by 13.5% and 11.9% in Spain and Greece, respectively. Enders, Sachsida and Sandler (2006) also estimate transfer functions to show that 9/11 had little lasting influence on U.S. FDI flows. Moreover, for a panel of countries, they also examine the effect of attacks against the U.S. on the stock of U.S. FDI. Their estimated gravity model shows that terrorist attacks had a significant, but small, impact on U.S. FDI in the OECD countries. The largest declines occurred in Greece and Turkey; U.S. FDI in these countries fell 5.7% and 6.5%, respectively. Abadie and Gardeazabalb (2008) use terrorism as a catastrophic risk in a standard endogenous growth model to examine the effects of changes in terrorist risk on capital allocations across two countries. Their model suggests that an increase in terrorist risk reduces expected return on investments which causes productive capital to be reallocated. To measure terrorist risk, they use the Global Terrorism Index from the World Markets Research Centre. They measure the amount of variance of net FDI stock that is explained by terrorist risk. Using a 110-country panel data set, they find that a one standard deviation increase in terrorist risk corresponds to a decline in the net FDI position equal to 5% of GDP.

It is important to note that the sustainability of terrorism, country size, openness, and market orientation are not independent of each other. We might anticipate that a sustained level of terrorism would have the largest effects in a small and open economy such as Israel. Eckstein and Tsiddon (2004) estimate a four-equation VAR to investigate the effects of terrorism on the

growth rates of Israeli real per capita GDP (ΔGDP_t), investment (ΔI_t), exports (ΔEXP_t) and nondurable consumption(ΔNDC_t) over the 1980Q1–2003Q3 period. Instead of measuring terrorism using the number of incidents, the terrorism variable is a weighted average of the number of Israeli fatalities, injuries, and noncasualty incidents due to both domestic and transnational attacks. For our purposes, the key portions of their model can be represented by:

$$\begin{bmatrix} \Delta GDP_t \\ \Delta I_t \\ \Delta EXP_t \\ \Delta NDC_t \end{bmatrix} = \begin{bmatrix} A_{11}(L) & \dots & A_{14}(L) \\ \vdots & \ddots & \vdots \\ A_{41}(L) & \dots & A_{44}(L) \end{bmatrix} \begin{bmatrix} \Delta GDP_{t-1} \\ \Delta I_{t-1} \\ \Delta EXP_{t-1} \\ \Delta NDC_{t-1} \end{bmatrix} + \begin{bmatrix} c_1 T_{t-1} \\ c_2 T_{t-1} \\ c_3 T_{t-1} \\ c_3 T_{t-1} \end{bmatrix} + \dots + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix} \quad (3)$$

where the expressions $A_{ij}(L)$ are polynomials in the lag operator L, the c_i measure the influence of lagged terrorism on variable i, and the e_i are the regression errors.

The nature of the VAR is such that ΔGDP_t, ΔI_t, ΔEXP_t, and ΔNDC_t are all jointly determined. In contrast, the terrorism variable (T_t) acts as an independent variable that can affect the other four variables. After estimating the coefficients of the model, they performed a counterfactual analysis to estimate the macroeconomic costs of terrorism. Specifically, they used the model to obtain out-of-sample predictions of ΔGDP_t, ΔI_t, ΔEXP_t, and ΔNDC_t assuming that all terrorism actually ended in 2003Q4 (so that all values of $T_j = 0$ for $j >$ 2003Q4). In this baseline forecasting exercise, the annual growth rate of *GDP* was estimated to be 2.5% through 2005Q3. When they fixed T_j at the 2000Q4 to 2003Q4 period average, the growth rate of GDP was estimated to be zero. Thus, a steady level of terrorism would have cost the Israeli economy all of its real output gains. The impact of terrorism on investment was twice that for real GDP and three times that for NDC_t. Finally, when Eckstein and Tsiddon (2004) set the level of terrorism at the levels observed during the intifada, the real GDP cost of terrorism was $1000 per

capita by the end of 2001, $1700 per capita by the end of 2002, and $2500 per capita by the end of 2003.

d. Market Based Economies

Sandler and Enders (2008) argue that market-based economies are relatively well-suited to respond to terrorism-induced changes in risks. The general point is that terrorism often necessitates a reallocation of resources across sectors. Terror-prone sectors shrink as consumers and producers shy away from risky activities and attempt to substitute toward safe activities. The necessary reallocation of resources is facilitated by a price system that appropriately reflects risks. For example, Abadie and Dermisi (2008) show how vacancy rates in the downtown Chicago real estate market quickly adjusted to reflect terrorism risk after 9/11. Commercial real estate prices will fall where vacancy rates are high and rise where vacancy rates are low. As such, the price system induces firms that are especially sensitive to terrorism risk to relocate into relatively safe areas and induces firms that that not especially sensitive to terrorism risk to relocate toward downtown Chicago. In contract, this type of signaling mechanism does not exist in command economies.

One market that is especially important is the market for insurance. As detailed in Kunreuther and Michel-Kerjan (2009), not all markets are perfect and there are many risks are not properly priced. This is especially true with large-scale risks, such as terrorism risk, that involve potentially catastrophic losses. Before 9/11, insured losses from terrorism had been moderate: $70 million in the 1993 NatWest tower bombing in London: $725 million in the February 1993 World Trade Center bombing; $671 million London financial district bombing in the 1992 financial district. The attacks of 9/11 resulted in $40 billion of insured losses. These losses prompted the insurance industry to exclude terrorism coverage or to charge extremely

high premiums. Kunreuther and Erwann (2004) report that insurance premiums at Chicago's O'Hare Airport jumped from $125,000 to $750 million annually. Smetters (2004) reports that the Golden Gate Park in San Francisco was unable to obtain any terrorism insurance and that its non-terrorism coverage fell from $125 million to $25 million while premiums more than doubled. The point is that there was a market failure in that insurance costs were excessive. The inefficiency costs associated with the market failure are certainly part of the overall cost of terrorism.

In order to circumvent the market failure associated with such large scale risks, congress passed the Terrorism Risk Insurance Act (TRIA) requiring commercial property/casualty insurers to provide coverage for certified terrorist events. Under TRIA, the government reimburses insurers for 85 percent of their losses after insurers pay a deductible. In 2007 Congress extended the program, now called Terrorism Risk Insurance Program Reauthorization Act (TRIPA), until 2014. While TRIA and TRIPA increased the availability of affordable terrorism coverage, a 2008 Government Accountability Office (GAO) report found that insurers generally do not cover losses due to chemical, biological, radiological, or nuclear (CBRN) attacks. Hence, some market failure remains because of the uninsurability of these large scale risks.

5. The Growth Costs of Terrorism Across Many Economies

Terrorism can impose economic costs by disrupting commerce, destroying tangibles such as factories and infrastructure, and by causing human casualties. As discussed above, attacks can impose other indirect costs by diverting foreign direct investment, tourism, international trade and short term capital flows. At first thought, it might seem possible to measure the costs of terrorism by adding up the costs to each segment of the economy and summing up the individual

costs. However, such a methodology is replete with problems. Even if it were possible to accurately measure the individual sectoral costs, it is not clear how to avoid double counting. To take a straightforward example, papers such as Chen and Siems (2004), Drakos (2004), and Elder and Melnick (2004) find that the effects of terrorism on stock prices are often significant. However, if asset markets are efficient, these effects only mirror the present discounted value of the real losses due to terrorism. Losses in the profitability of the airline industry and lost tourism revenues are really different ways of expressing the same phenomenon. Adding them together would clearly be double counting. Another reason to avoid adding up the sectoral losses is that large scale terrorist attacks cause reallocations of people and resources across sectors. For example, in conjunction with the 9/11-induced decline in air travel, many U.S. tourist destinations experienced increased demand as people took fewer vacations necessitating an airplane flight and more vacations to areas that were within driving distance from their home. To calculate the net cost of 9/11, it is necessary to include the gains that these areas experienced. The problem, of course, it that it is relatively easy to measure the heavy losses experienced by some areas but very difficult to measure the small indirect gains experienced by thousands of areas. Instead, it seems better to calculate the costs of terrorism using macroeconomic tools that allow for sectoral changes. Nevertheless, the time-series methodology used by Eckstein and Tsiddon (2004) is not feasible when considering a large number of economics.

Blomberg, Hess, and Orphanides (2004), henceforth BHO, measure the lost per capita income growth for countries experiencing one or more transnational terrorist. Specifically, BHO (2004) estimate the following relationship for a panel study of 177 countries over the 1968–2000 sample period:

$$\Delta y_i = -1.200\ \mathrm{COM}_i - 1.358\ \mathrm{AFRICA}_i - 0.461 \ln y_0 + 0.142\ I/Y_i - 1.587\ T_i, \qquad (4)$$

where Δy_i is country i's per-capita average growth rate over the entire sample, COM_i is a dummy variable equal to 1 for a non-oil commodity exporter, AFRICA is a dummy variable equal to 1 for African nations, $\ln y_0$ is the log of the initial value of GDP, I/Y_i is country i's per-capita average rate of investment's share of GDP over the entire sample, and T_i denotes average number of years in which there was at least one terrorist event in country i. All variables are statistically significant at the 1% level.

The point estimates indicate that the growth rates of African nations and of non-oil commodity exporters are 1.2 percentage points and 1.358 percentage points lower than those of other countries, respectively. The coefficient of $\ln y_0$ captures the tendency of large countries to have lower growth rates than small countries while the coefficient of I/Y_i reflects the tendency of countries investing large shares of their income to have high growth rates. For our purposes, the key term is the coefficient on the terrorism variable. The coefficient of 1.587 indicates that for each year a country experiences a terrorist incident, its per-capita growth falls by 1.587/33 = 0.048 percentage points. Similarly, if it experienced at least one incident in every year of the sample, its growth would be 1.567 percentage points lower than otherwise. The results seem to be plausible and their findings are quite robust to other specifications and various estimation techniques. In an interesting extension, BHO (2004) augment equation (4) with other forms of political violence. When they include terrorism and these other forms of conflict in the same equation, they report that the growth consequences of external wars and internal conflicts are larger than those of terrorism. Yet, this is the expected result since terrorism is a tactic that may or may not be employed in warfare. Internal conflicts that include terrorism have larger growth losses than other internal conflicts.

In a companion study, Tavares (2004) argues that the overall macroeconomic costs of

terrorism are low. Consider his model estimated for an unspecified sample of countries over the 1987-2001 period:

$$\Delta y_{it} = \beta_1 \Delta y_{it-1} + \beta_2 Y_{it} + \beta_3 T_{it} + \text{other covariates} + \varepsilon_{it}, \quad (5)$$

where Δy_{it} is real per capita GDP growth of country i in period t, Y_{it} is i's level of real per capita GDP in t, and two measures of terrorism are used. Alternatively, T_{it} is either the total number of attacks per capita or the total number of casualties per capita. The other covariates included a natural disaster index and a currency crisis index.[6]

Regardless of which terrorism measure was used, T_{it} had a small and negative impact on annual GDP growth. Moreover, when other determinants of growth (e.g., an education variable, trade openness, primary goods exports, and the inflation rate) were introduced into the estimating equation, T_{it} became statistically insignificant and/or positive. The finding that growth cost of terrorism is essentially zero for all countries and for all time periods strains credibility. One problem is that panel data estimates "average out" the costs of terrorism for widely diverse nations. It would have been interesting to examine whether certain subpanels of nations experienced significant levels of terrorism. Another explanation for the findings is that terrorism is correlated with the education variable, trade openness, primary goods exports, and/or inflation so that coefficient magnitudes and the usual t-tests are misleading.

Tavares (2004) also compared the costs of terrorism in democratic versus nondemocratic countries. The key portion of his regression equation dealing with political rights is:

$$\Delta y_{it} = 0.0261\, y_{it-1} - 0.029 T_{it} + 0.121(T_{it} \times R_{it}) + \text{other explanatory variables} \quad (6)$$

where R_{it} is a measure of political rights in country i in year t. R_{it} ranges from 0 to 1 with a

[6] Tavares (2004) uses instrumental variables to correct for any simultaneity between terrorism and real per capita GDP growth. However, unlike BHO, Tavares (2004) does not control for internal conflicts.

sample mean of 0.53.

In contrast to Tavares' original specification, all of the coefficients in the equation involving terrorism are statistically significant. The positive coefficient on the interaction term $T_{it} \times R_{it}$, means that the effect of a typical terrorist attack decreases as the level of political freedom increases. The argument is that democracies are better able to withstand terrorist attacks than other types of governments with less flexible institutions. This is consistent with the view discussed in Enders and Sandler (2008) that the cost of an attack in a democracy is lower than in other governmental forms because they rely on markets to allocate resources. The point estimates indicate that the growth effect of a single terrorist incident in country i in year t is $(-0.029 + 0.121R_{it})$ percentage points. Thus, for a nation with few political rights (so that R_{it} is near zero), terrorism reduces annual growth by –0.029 percentage points. Since the model is dynamic, this growth effect has some persistence. Nevertheless, the results are a bit problematic because the point estimates of the coefficients imply that terrorism can enhance growth. For a country with the average level of political rights (i.e., $R_{it} = 0.53$), the influence of a terrorist attack on growth is +0.03513 percentage points. It would have been interesting if results using T_{it}, R_{it} and $T_{it} \times R_{it}$ as explanatory variables were reported. In this way, the independent influence of R_{it} on growth could have been ascertained. Also, since the independent influence of R_{it} is excluded from the regression, the coefficient of $T_{it} \times R_{it}$ is probably biased upward.

Sandler, Arce and Enders (2009), hereafter SAE, use the BHO findings to calculate the total value of terrorism-induced GDP losses. Specifically, they use equation (4) to perform a counterfactual experiment to determine what per-capita GDP levels would have been had there been no terrorism. The difference between the actual and estimated GDP levels is the terrorism-

induced GDP losses. Using population (Pop), actual per capita GDP in 2005, and the growth rate of per capita GDP between 2004 and 2005, it is possible to calculate the terrorism-induced GDP losses. Given that the coefficient on terrorism is –1.587 and that the terrorism variable is the average number years in which there was at least one terrorist event in country *i*, Sandler, Arce and Enders (2009) calculate the cost of terrorism for each country (C_i) using the formula:

$$C_i = (T_i/5)(\text{Pop} \times \text{per capita GDP}) \times (2005 \text{ growth}/100) \times 0.048. \quad (7)$$

where 0.048 = 1.587/33 represents the BHO estimate of the growth cost of terrorism in any one year of their 33-year sample, and (T_i/5) is the fraction of years during 2001-2005 that a country experiences one or more transnational terrorist attacks.

In addition to the BHO measure of terrorism, SAE used the actual number of incidents in 2005 as well as the fraction (T_i/5). Using the first measure of terrorism, the total GDP lost in 2005 is approximately $19.412 billion. Using the second method, the cost for 2005 was $17.363 billion. Using a 5% interest rate to capitalize these losses over five years, SAE computed a present value for all countries yields a five-year GDP costs of $83.407 billion.

Blomberg (2009) presents an alternative modeling strategy, yet reaches very similar findings to those of SAE. In particular, Blomberg (2009) notes that terrorism is associated with other forms of conflict. As such, he argues that any terrorism-induced conflict should be included as an indirect cost. He calculates that the presence of one form of conflict raises the probability of the other by 7.7 percent. If a 0.05 discount factor is used, for a five-year period, the presence of a terrorist event increases the likelihood of conflict by 35%. Given the differential weights of terrorism and internal conflict on growth, Blomberg (2009) calculates that the effects of terrorism should be scaled upward 25% to account for the induced effect of terrorism on other forms of conflict.

6. The Cost of Lost Lives and Injuries

In addition to GDP lost, the direct costs of terrorism include the loss of life, the injuries and the personal suffering resulting from a terrorist attack. Although many are reluctant to place an economic value on human life, Sandler, Arce and Enders (2009) suppose that the typical worker earns $5000 per year. Obviously, $5000 figure is low for the individuals in industrialized nations but far exceeds the levels of many nations. Thus, the 550 deaths resulting from transnational terrorism in 2005, amounted to an economic loss of $2,750,000. Next, SAE calculated the present discounted value of this lost income stream using several assumptions concerning life expectancy, and the discount rate. When they used a 5% discount rate and a life expectancy of 62.5 years, the total economic loss was calculated to be $43,471,000.

Although measuring the costs resulting from wounds and other casualties is replete with difficulties, Sandler, Arce and Enders (2009) devise the following methodology. As a first step, they use the results of a survey by Abenhaim, Dab, and Salmi (1992) concerning the physical and psychological injuries suffered from a terrorist attack. For example, for victims in the typical attack 46.9% suffered a hearing loss, 15.4% suffered severe burns, 28% suffered head or eye trauma, 6.7% suffered from respiratory impairment, 4.5% fractures and/or amputations, and 31.4% suffered from post-traumatic stress or major depression. The total sums to more than 100% since some individuals experienced multiple symptoms. Each of these attributes can be applied to the typical terrorist incident. Hence, if there happened to be 100 casualties in a particular time period, the methodology would assume that 46.9 people suffered a hearing loss, 15.4 suffered severe burns, 31.4% suffered from stress or major depression, and so forth. Each of these disorders was given a disability weight based on Mathers, Lopez, and Murray (2003). The disability weights represent the proportionate productivity loss of the individual. Some of the

other disability weights are: head trauma = 0.15, severe burns = 0.26, respiratory impairment = 0.26, and respiratory impairment = 0.28. The notion is that the typical individual experiencing, say, severe burns from a terrorist attack is 26% less productive than an uninjured individual. Of course, a death receives a weight of unity since the income loss is complete.

Once the complete set of disability weights is applied to the injury types, it is possible to determine the total value of casualty losses. Given that in 2005, there were 864 casualties, it is estimated that there are 133 people with severe burns. Using the weight of 0.26, there was annual loss of $5000*133*0.26. Using a 5% discount rate and assuming that the average burn victim would live 62.2/2 years, the loss from this type of injury was estimated to be $2,681,700. Repeating this type of calculation for each type of disability, yielded a total of $21,622,000. Adding the loss of life to the costs of casualties yields a total of $65,093,083.

Note that this measure of direct costs excludes the costs of pain and suffering to those injured in a terrorist attack. It also excludes the dollar value of the fear engendered by terrorists.

7. Homeland Security Costs

Homeland security spending is certainly one of the larger costs of terrorism. However, this figure is especially difficult to calculate since national budgetary figures for homeland security spending are not directly reported. Moreover, it is difficult to allocate expenditures for many types of actions between uses. For example, in addition to protecting the nation from terrorism, the activities of the Coast Guard protect borders from illegal immigrants and aid commercial and shipping and private boating activities.

Hobijn and Sager (2007) estimate that homeland security spending rose from $56.0 billion in 2001 to $99.5 billion in 2005. Federal government spending rose by $32.4 billion, state and local governments spending rose by 1.7 billion, and private sector spending rose by $9.4

billion. This $43.5 billion increase in total homeland security spending amounted to 0.35% of U.S. GDP. It seems reasonable to ascribe much of this increase to terrorism since there was a large jump in federal government spending following 9/11 and only modest changes thereafter. Private sector homeland security spending as a share of GDP remained fairly constant at 0.46% of GDP. However, homeland security spending includes intelligence, border and transportation security, counterterrorism, protection of critical infrastructure, defense against catastrophic threats, and emergency preparedness and response. For our purposes, the key point to recognize is that only about 7% – 10% of these expenditures are explicitly directed toward counterterrorism. If these figures are accurate, an extremely small portion of U.S. resources are used to thwart terrorism.

SAE employ Hobijn and Sager's (2007) result that homeland security spending increased by 0.35% of U.S. GDP. Treverton (2008) found that U.K. security homeland security spending increased by 0.146% of U.K. GDP. In their recommended scenario, SAE apply the U.S. ratio to the U.S., Israel and Russia, the U.K. ratio to the U.K. and a 0.05 percent ratio to all other nations' 2005 level of GDP. Summing across all nations yields a value of $64.42 billion.

Blomberg (2009) modifies the SAE methodology by assuming that homeland security costs are a constant fraction of total military spending (not GDP). Moreover, he also includes the increased cost of international organizations (such as INTERPOL and the IMF) and the cost of increases proactive measures by calculating the cost of US military intervention in Iraq and Afghanistan. Nevertheless, his results are very similar to those of SAE. Although there is some double counting, the 2005 GDP losses of approximately $19.412 billion, the loss-of-life and casualty costs of $65,093,083 and the homeland security costs of $64.42 billion add to about $150 billion.

7. Life Satisfaction

Probably the most difficult cost to measure is the psychological cost that stems from a possible terrorist attack. Frey, Luechinger, and Stutzer (2009) use the *Life Satisfaction Approach* (LSA) to measure the "fear, grief and mourning" that are part of the cost of terrorism. The issue at hand is: How much would you pay to be completely independent of terrorism? The LSA requires that life satisfaction scores reported in survey responses are sufficient to reveal the "global" evaluation of the individual's life and are comparable across individuals. Hence, although life satisfaction scales are ordinal, if individual A reports a higher score than B, then A is more satisfied with his/her life than B. The point is that the reported subjective well-being of an individual can be used to assess that individual's preferences for public goods or externalities.

Consider a hypothetical experiment such that individuals in a terror-prone region report lower life satisfaction then individuals in a peaceful region. Properly controlling for other explanatory variables (including regional fixed effects and time effects) the differences are attributed to terrorism.

Methodologically, it seems desirable to find very similar areas that differ only in their levels of terrorism. Fortunately, good survey data exists for France and the British Isles. In the case of France, Frey, et. al. (2009) use the Ile-de-France (which includes Paris), Provence-Alpes-Côte d'Azur (including Corsica) and the remainder of France. Many terrorist incidents occur in Paris but the other main differences across regions are small. Similarly, there are time periods during which Corsica experiences many attacks. In the British Isles, Great Britain, Northern Ireland and the Republic of Ireland experience very different patterns of terrorism.

The authors use peoples' reported measures of life satisfaction. Specifically, for most years between 1973 and 2002, individuals were asked: "On the whole, are you very satisfied [4],

fairly satisfied [3], not very satisfied [2], or not at all satisfied [1] with the life you lead?" The questionnaire also included personal and demographic characteristics such as the individual's income class, gender, age, marital status, and employment status. The authors report 30,244 responses for Great Britain, 7,891 for Northern Ireland, 24,185 for the Republic of Ireland, and 38,062 for France. Terrorism was measured by the number of terror attacks and the number of fatalities resulting from the attacks.

For our purposes, the key feature of the paper is the regression equation:

$$LS_{irt} = \beta_0 + \beta_1 T_{rt} + \beta_2 \ln(m_{irt}) + \beta_3 Z_{irt} + \ldots + \varepsilon_{irt} \quad (8)$$

where LS is life satisfaction, T is the level of terrorism, m = individual household income, Z is a vector of personal characteristics, and subscripts i, r and t refer to individual i living in region r during time period t. Other regressors include time fixed effects.

The estimated values of β_1 for the two measures of terrorism (with t-statistics in parentheses) are

	Incidents	Fatalities
British Isles	$-7.6*10^{-5}$	$-6.4*10^{-4}$
	(–3.90)	(–3.45)
France	$-2.2*10^{-3}$	$-5.00*10^{-2}$
	(–2.74)	(–2.50)

Note that terrorism reduces life satisfaction in all cases. A one standard deviation in the number of incidents in the British Isles lowers the life satisfaction measure by 0.012 points. Similarly, for France, a one standard deviation in the number of incidents lowers the life satisfaction measure by 0.013 points. The effects seem to be quite large in that they are equivalent to shifting about 1% of the population from the very satisfied to the fairly satisfied category.

The key to the methodology is determining the increase in income that would be necessary to restore life satisfaction. For example, a doubling of income in the British Isles life satisfaction would rise by 0.116 points. Thus, it is possible to find people's willingness to pay for the elimination of terrorism. The paper reports individuals' willingness to pay for a reduction in terrorism to levels in the relatively tranquil parts of the nation.,

The compensating surpluses for a reduction in terrorism in various regions are:

Table 2

	Northern Ireland		Paris	
Average annual household income	$20,501		$26,067	
Reduction in terrorism	1022.76 acts	77.04 deaths	9.58 acts	2.16 deaths
Willingness to pay	$7,641	$5,252	$2,149	$1099
Percent of income	37.3%	25.6%	8.2%	4.2%

For example, in Northern Ireland, with an average annual household income of $20,501, people would pay an average of $7,641 to eliminate 1022.76 acts of terrorism. Even though the numbers seem large, Frey et. al. (2009) argues that they are plausible given the ferocity of the conflict, curfews, large scale riots and reductions in civil liberties in Northern Ireland.

8. Why Can Indirect Costs Exceed Direct Costs?

Many people think that the main costs of terrorism are the various direct costs discussed in Section 3. Yet, as was the case with 9/11, the indirect costs of an attack can far exceed the direct costs. One reason for a low ratio of direct costs to indirect costs is that the two can be negatively related; some indirect costs—such as increases in expenditures designed to thwart terrorism—act to reduce the direct costs from terrorism. If homeland security expenditures perfectly protected the nation against terrorism, the direct costs of all terrorist attacks would be

zero. The general point is that a low ratio of direct to indirect costs can simply mean that homeland security expenditures are effective.

Moreover, terrorist groups are often more interested in maximizing the indirect costs of their attacks rather than maximizing the direct costs. Terrorism is designed to be an act of asymmetric warfare. As they explicitly attack noncombatants, terrorists usually have little hope of a direct military victory. Instead, their aim is to impose costs on the general population so that the government capitulates to some (or all) of the terrorists' grievances. Terrorists understand that the private and government sectors will undertake expenditures designed to reduce the number, severity and/or consequences of terrorist attacks. There is growth cost of security since the resources used for protection could have been used to produce final goods and services.

Several papers have tried to measure the linkages between political violence, security spending and growth. BHO (2004) estimate a number of panel regressions to determine the effect of terrorism on the level of investment and government expenditure. Consider:

$$G/Y_{it} = 2.925 \ln op_{it-1} - 2.238 \ln y_{it-1} + 0.490 T_{it} + \text{other explanatory variables} \quad (9)$$

where G/Y_{it} is the ratio of government spending to GDP in country i during period t, op_{it-1} is a measure of lagged openness for country i, y_{it-1} is lagged real per capita GDP in country i, T_{it} is a measure of the level of terrorism in i during t, and all coefficients are significant at the 1 percent level.

Note that openness and terrorism are associated with a large share of government spending in GDP whereas G/Y_{it} is negatively related to the lagged level of GDP. When the dependent variable is replaced by real investment, the coefficient on terrorism becomes negative and statistically significant. This is consistent with the notion that government spending aimed at

reducing terrorism replaces private capital formation. The net effect is that government spending crowds out private capital formation leading to a reduction in the level of economic growth.

Gupta et al. (2004) use a different methodology to measure the interactions between conflict, government spending and economic growth. We can write their growth equation as

$$\Delta y_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 Def_{it} + \beta_3 Conf_{it} + \beta_4 Inv_{it} + \text{other demographic variables} + \varepsilon_{it} \qquad (107)$$

where y_{it} is real per capita GDP growth of country i in period t, Y_{it} is i's level of real per capita GDP in the initial year of the sample period, Def_{it} is the share of defense spending in total government spending, $Conf_{it}$ = a measure of internal conflict and terrorism, and Inv_{it} is total investment relative to GDP. Instead of using annual data, the time subscript refers to the 5-year annual averages of the periods 1980-1984, 1985-1989, 1990-1994, and 1995-1999.

The model is closed by specifying equations for defense expenditures and tax revenues (Tax_{it}). Since they allow Def_{it} and Tax_{it} to be functions of the conflict variable, there are actually two channels by which conflict can effect growth; conflict affects Δy_{it} directly and conflict affects Def_{it} which affects growth directly.

Since $Conf_{it}$ may be affected by the level of growth and/or Def_{it} the equations are estimated using the generalized method of moments (GMM) in order to control for simultaneity. Although a number of different specifications are reported in the paper, Def_{it} statistically decreases growth and $Conf_{it}$ significantly increases Def_{it}. In the baseline version of their model, for example, the estimate of β_3 is –0.37. Unfortunately, $Conf_{it}$ does not separately identify the differential effects of domestic terrorism versus transnational terrorism of the effects of different types of conflict growth. As such, they simply report that terrorism significantly inhibits growth, and not the actual cost estimates for any of the countries used in the study. Moreover, as indicated by BHO, Inv_{it} is highly correlated with conflict and government deficit spending. Thus,

it is not clear why this variable was treated as an independent variable. After all, the aim of some terrorists is to target foreign firms so as to reduce the level foreign direct investment and foreign influence in their economy.

Gaibulloev and Sandler (2009) investigate the influence of terrorism and other forms of conflict on growth in the Asian countries over the 1974-2004 period. Specifically, they add terrorism and conflict variables to a standard growth model similar in form to that of BHO. They report that one additional terrorist incident per million persons reduces GDP per capita growth by about 1.5%. In harmony with previous literature they find that transnational terrorism has a significant growth effect for developing countries but that developed countries do not display adverse growth consequences. They attribute the negative economic consequences present in developing countries to the increased government security spending crowding out productive private investment.

9. The Future

All of the costs described thus far pertain to events that have occurred. Although no attack has been as costly as 9/11, the concern is that a future chemical, biological, radiological or nuclear (CBRN) attack could be even more dreadful. CBRN attacks are logistically more complex than conventional attacks and can be exponentially more costly. The GAO (2008) reports the results of several different studies measuring the potential losses from a CBRN attack in New York City.

Chemical attacks could fall into four categories: nerve agents, blood agents, choking agents, blistering agents. The 1995 sarin nerve gas attack on the Tokyo subway by Aum Shinrikyo killed twelve commuters and injured between 1000 – 5000 others. The effects of the attack were mild since the gas was more difficult to disperse than anticipated. The GAO reports

that a similar sarin nerve gas in New York could result in losses of $34 billion and cause 6,000 fatalities. While this estimate is significantly higher than the damages from the 1995 attack, the GAO figure assumes that the nerve gas is dispersed effectively.

Biological attacks fall into four groups: poison, viruses, bacteria, and plagues. Kaufmann, Meltzer, and Schmid (1997) calculate that for every 100,000 persons exposed, the economic impact of a bioterrorist attack can range from an estimated $477.7 million for a brucellosis attack to $26.2 billion for an anthrax attack. The death toll per 100,000 from an anthrax attack could be about 32,000 and another 50,000 could be diseased. These figures are similar to those of the GAO; the GAO indicates that a 10 kilogram anthrax slurry could result in 80,000 fatalities and $254 billion in losses. The anthrax attacks of September and October of 2001 frightened a public already sensitized to terror from 9/11. In total five people were killed and seventeen other people were infected from the anthrax spores mailed to the offices of U.S. Senators Tom Daschle and Patrick Leahy and a number of news organizations. Nevertheless, the cleanup costs were far less than the Kaufmann, Meltzer, and Schmid (1997) or GAO estimates. The GAO reports that about $27 million of the EPA's Superfund was spent on the Capitol Hill cleanup and a total of $300 million was spent on the cleanup of other government buildings and the two post offices that handled the anthrax letters. The reason for the disparity between actual and anticipated costs is that biological agents are particularly difficult to weaponize.

The materials necessary for a radiological attack, particularly a dirty bomb, are relatively easy to obtain and can be dispersed through conventional terrorist means. Gordon, Moore, Richardson and Pan (2005) estimate that two simultaneous radiological attacks on the twin ports of Los Angeles could have a total cost of $34 billion and 212,000 jobs. The GAO (2008) reports that a dirty bomb detonated in New York City could cost $43 billion. Casualties from a dirty

bomb attack would likely occur only from the blast or dispersion of the agent resulting in few fatalities; however, the effects could drastically decrease the quality of life.

The reported costs of a nuclear attack are purely speculative. Nuclear attacks likely would occur from nuclear plant sabotage or from the detonation of a small nuclear device. The GAO (2008) estimates that nuclear power plant sabotage could cause $217 billion in damages but take a relatively few number of lives. A tactical 5 kiloton bomb is estimated to cause $584 billion and take 3 million lives. Under a RAND Corporation simulation of a nuclear explosion in the Port of Long Beach, California would result 60,000 instant fatalities with 150,000 injuries and economic losses of up to $1 trillion.

Arquilla, Ronfeldt, and Zanini (1999) and Enders and Su (2006) argue that al Qaeda's ability to conduct sophisticated highly-coordinated actions has been diminished as its network structure has become looser. This is important because the logistical complexities of weaponizing biological agents or detonating a nuclear device far exceed those of conducting chemical or radiological attacks. This supports Enders and Sandler's (2006) claim that chemical attacks appear to be the most likely attack to occur in the future in that they are easy to obtain and disperse in a cost-effective manner.

10. Conclusion

The recent increase in the number and lethality of terrorist attacks likely means that the costs associated with terrorism will continue to increase. For large diversified economies that rely on the price mechanism, such costs are anticipated to be relatively small. This is true even though liberal democracies generally experience more terrorism than smaller and highly-specialized economies. Developed countries can rely on the price mechanism to reallocate resources across sectors and they are able to utilize fiscal and monetary policies to mitigate the

long-term consequences of large-scale attacks. The macroeconomic growth costs of terrorism are the result of increased counterterrorism policies designed to thwart subsequent attacks. However, this increased government spending acts to crowd out private sector investment. The microeconomic costs of terrorism tend to be concentrated in the tourism, trade, and transportation sectors, and in a nation's net foreign direct investment. Small-open economies tend to be highly concentrated in such sectors. While the costs of possible CBRN attacks are purely speculative, even a small radiological attack in occurring New York City could generate direct costs equal in scale to those of 9/11.

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Figure 1: Transnational Terrorist Events

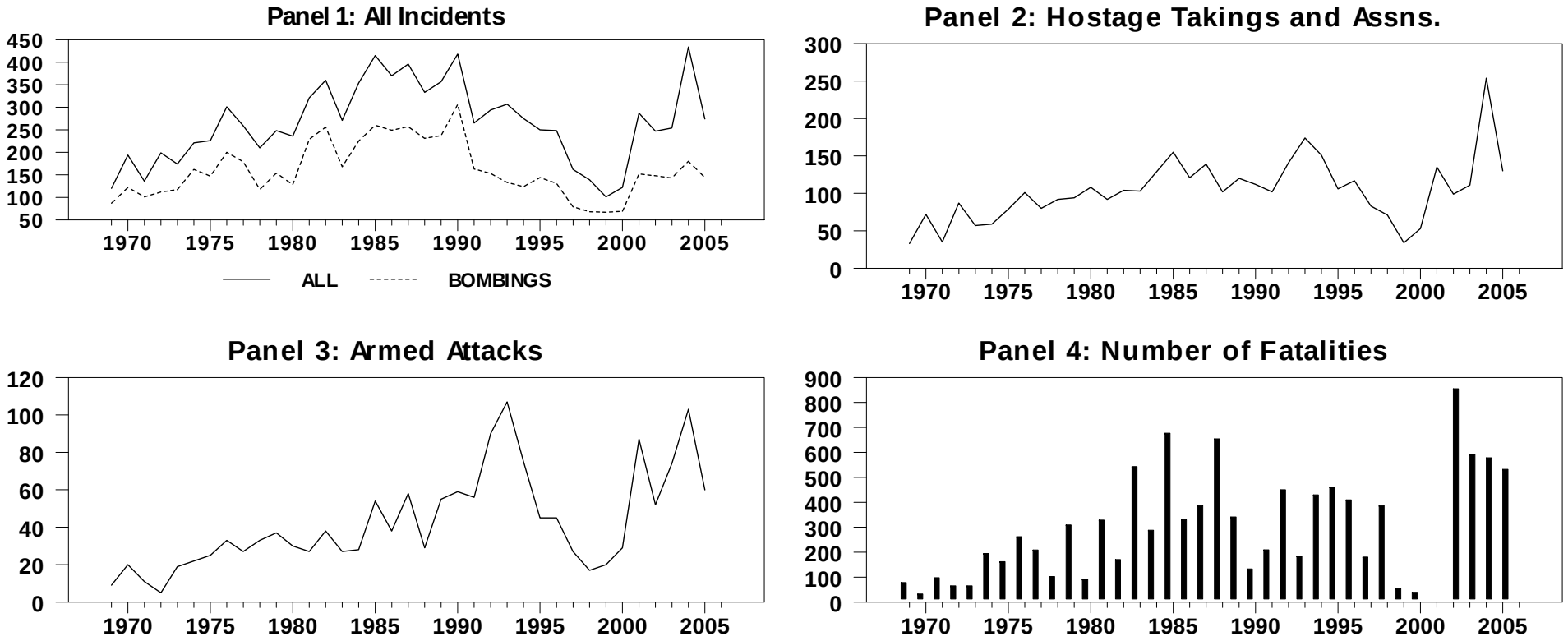

Figure 2: Number of Domestic and Transnational Incidents