

THE ECONOMIC ANALYSIS OF LONE WOLF TERRORISM

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ABSTRACT

Purpose:

This chapter explains how economic analysis can contribute to the delineation of the lone wolf's opportunities and choices in a manner that allows operationally relevant advice to be contributed to the investigative process.

Approach:

Using a risk-reward analytical framework we examine the lone wolf's attack method opportunities and choices and identify those attack methods that would be chosen by lone wolves with different levels of risk aversion. We also use prospect theory as an alternative methodology for the determination of the lone wolf's preference orderings over the available attack methods in a context where he references his actions against those of a predecessor whom he wishes to emulate.

Findings:

We find that lone wolf terrorists with different levels of risk aversion can be expected to choose different attack methods or combinations of attack methods. More risk averse lone wolf terrorists will choose attack methods such as assassination. Less risk averse lone wolf terrorists will choose attack methods such as bombing, hostage-taking and unconventional attacks. Also, we find that lone wolf terrorists who reference their actions against 'predecessor' lone wolf terrorists will choose differently from among the available attack methods depending on which predecessor lone wolf is being referenced.

Limitations:

The analysis provides two different perspectives on terrorist choice but by no means exhausts the analytical alternatives. The analysis focuses on the fatalities and injuries inflicted whereas other perspectives might include different 'payoffs' series, including news or media coverage.

Originality:

The chapter contributes an analysis of the order in which lone wolf terrorists with particular characteristics will choose from a set of available attack methods. During the course of our discussion we point out the consistency between the 'rise' of the lone wolf terrorist and the diseconomies to scale that are evident within the terrorism context. This presents the opportunity for new debates.

Keywords: Lone wolf terrorism; Lone wolf terrorist; Economic analysis; Investigative process; Risk aversion; Opportunities; Choices; Attack methods; Prospect theory; Preferences.

JEL Classification: H56, D74, D81

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INTRODUCTION

The purpose of this chapter is to explore some of the ways in which economics may be helpful in the pre-emption, pursuit and apprehension of the lone wolf terrorist. The ‘true’ or ‘pure’ lone wolf terrorist operates alone, outside of any command structure or formal organisation. He presents a challenge to law enforcement because his independence makes it difficult to detect evidence of his existence before he strikes. Lone wolf terrorists do not have a network that can be infiltrated by government security agencies. Even the ‘quasi’ lone wolf terrorist who engages in some level of interaction with known potential terrorists or maintains some links with extremist organisations will be more difficult to identify, track and apprehend prior to an attack than those who choose to operate within a formal command structure and information and supply network. We must not fall into the trap of thinking that a single individual cannot obtain the information and materials required to inflict human tragedy upon civilians. Most lone wolf attacks have been relatively crude in terms of the materials required but have sometimes demonstrated sophistication in planning that rivals or exceeds that of known terrorist groups. Some lone terrorists have inflicted more injuries and fatalities than many terrorist groups.

For these reasons, the lone wolf terrorist has figured prominently in the Federal Bureau of Investigation’s (FBI) strategic planning for almost a decade. The then FBI’s (Acting) General Counsel, Patrick Rowan, highlighted the threat of lone wolf terrorism in testimony before the House Intelligence Committee in 2003 (Webster Commission, 2012, p. 9). In 2011, both the President of the United States, Barack Obama, and the U.S. Homeland Security Director Janet Napolitano named lone wolf terrorism as the greatest threat to be guarded against. According to the Associated Press, Janet Napolitano said, “The risk of ‘lone wolf’ attackers, with no ties to known extremist networks or grand conspiracies, is on the rise as the global terrorist threat has shifted.” She was quoted as saying, “There’s been a lot of evolution over the past three years. The thing that’s most noticeable to me is the growth of the lone wolf” (Associated Press, 2011).

The recent attention that lone wolf terrorism has received from governments and their security agencies should not lead us to overlook the long history of lone wolf terrorism in both the United States and Europe. Indeed, if lone wolf terrorism is a ‘rising threat’, then there is certainly an argument to be made that the threat has been rising for a long time. The narrative of lone wolf terrorism stretches back at least several decades. In the United States between 1978 and 1999, 26 percent of the victims of terrorism were victims of lone wolf terrorism and the number of recorded incidences of lone wolf terrorism rose from just 2 during the 1960s to 13 in the 1990s (Spaaij, 2010, pp. 859-860). 30 cases of lone wolf terrorism were reported in the U.S. between 1968 and 2007. Over the same period 9 cases were reported in Germany, 7 in France, 6 in Spain and 5 in Italy². The actions of Anders Behring Breivik in July 2011, which resulted in the deaths of 77 people, became the most deadly incidence of lone wolf terrorism, overshadowing the 18 fatalities attributed to the actions of Joseph Paul Franklin in the U.S. in the 1970s.

What makes the challenge facing law enforcement more acute is the absence of any particular ‘profile’ for lone wolf terrorists. Lone wolves often hold ‘extreme’ views but different lone wolves hold these extreme views

² Though when Europe is considered as a whole, there were 38 lone wolves active during the period throughout Europe (Instituut voor Veiligheids en Crisismanagement, 2007).

about different things and many people with extreme views do not end up expressing them violently in an act of terrorism. A number of cases of lone wolf terrorism in the United States have apparently been motivated by extreme views on race and abortion. Racially motivated acts of terrorism have been among the most deadly instances of lone wolf terrorism. For example, Joseph Paul Franklin, a white supremacist who engaged in a series of racially motivated shootings between the late 1970s and early 1980s, killed 18 and injured 5 people and Mark Essex, a black militant, accumulated an identical number of victims—though with 10 fatalities and 13 injuries—in a one week spree of violence in 1973. Ten of Essex's victims were police officers, whom he deliberately targeted in an attack on the New Orleans P.D. on New Year's Eve 1972. One officer was killed and one injured in the initial attack. Others were killed or wounded in the ensuing pursuit along with several civilians. Franklin is currently serving multiple life sentences for his crimes. Essex was shot and killed by police on January 7 1973, one week after his initial attack.

Neither the backgrounds nor motivations of lone wolf terrorists reveal any strongly discernible patterns. Indeed, it is hard to construct a representative 'profile' for lone wolf terrorists in general. Just about the only thing that lone wolves appear to have in common is that nearly all lone wolf terrorists have been male. Rachelle Shannon, an anti-abortion activist who shot and wounded a doctor in Wichita, Kansas, is the only female to engage in an act of lone wolf terrorism in the United States. Beyond this, the characteristics and motivations of lone wolf terrorists are divergent enough to prevent a profile for an archetype lone wolf from being constructed. This is essentially the same situation that has been found to characterise terrorists in general and far-reaching and comprehensive analysis of offenders from psychological and socio-economic-environmental perspectives have failed to identify any finite list of things that terrorists have in common (Rasch, 1979; Victoroff, 2005). This being said, work is ongoing in defining and refining the categories of lone wolf terrorism and it might still be possible that within particular sub-sets of motivations patterns will emerge that will help to develop a typology of the characteristic lone wolf offender.

One of the most recent and most deadly acts of lone wolf terrorism in the United States occurred on November 5 2009 when Nidal Malik Hasan, a U.S. Army Major, used two pistols to kill 13 people—12 U.S. soldiers and 1 Department of Defence employee—and injure 43 others in a shooting spree at the U.S. Army base in Fort Hood, Texas. The William H. Webster Commission, which was established to investigate the FBI's responses to pieces of intelligence obtained prior to the shooting, has further highlighted the challenges that lone wolf offenders present to law enforcement agencies. On the face of it, events such as 9/11 and the Fort Hood shootings may lead us to the conclusion that 'religious extremism', particularly of the Islamic type, is a prominent category of modern lone wolf terrorism within which most potential lone wolf terrorists can be grouped and on which law enforcement efforts can be concentrated. However, the Commission's report highlights the fact that Islamic religious extremism has accounted for only 7 percent of terrorist incidences in the United States. The two other overarching categories of extremism, 'political' and 'social', are much more significant. This, of course, highlights immediately the problem of classifying lone wolf terrorists. The task would be easy if most of them could be placed within the category of 'religious extremists' and further classified into the subset Islamic extremism. When political and social extremism are dominant overarching categories, each with diverse subsets

of motivations, the task of deciding which types of behaviour will attract law enforcement attention is more complex.

The purpose of the FBI's model of the radicalisation process, which is consistent with similar models developed in Coolsaet (2011) and Ranstorp (2010), is to determine a set of 'indicators' that identify a potential lone wolf terrorist before he strikes. The model is relatively straightforward (Webster Commission, 2012, p. 8):

Pre-radicalisation → Identification → Indoctrination → Action

This involves a dual challenge. First, the radicalisation of a particular 'lone' individual may not be observable prior to action. Second, even if there are some observable indicators of radicalisation, these may or may not be 'actionable' within the legal and constitutional frameworks that exist. As the Webster Commission's report clearly states, radicalisation is not a crime. Evidence that the potential offender is planning a violent action is required before an individual can be taken into custody. One important reason to justify a heightened level of concern about the potential for lone wolf terrorism perpetrated by radicalised or extremist individuals is that the process of radicalisation may be becoming less visible, more multifaceted in its origins and faster in its evolution towards violent action. The last two stages of the radicalisation process are known to proceed with greater pace than the first two but growing prominence of the Internet as a means to obtain and distribute information at little or no cost and hidden amongst large volumes of other electronic information may contribute to both a general acceleration in and 'cloaking' of all four stages of radicalisation making it even more difficult to detect a lone wolf terrorist before he engages in a violent action (Webster Commission, 2012, p. 10).

Economic analysis can contribute several things to investigative processes designed to pre-empt and pursue the lone wolf terrorist. Fundamentally, economics is about 'opportunities' and 'choices'. It is a set of analytical tools and theoretical frameworks that are used to identify the opportunities that individuals face—called the 'opportunity set'—and the choices that they make from the available opportunities. Applied to the analysis of terrorism, economic analysis will focus on determining the opportunities and choices that terrorists face. Because violent actions are the most pernicious actions of 'radicalised' or 'extremist' individuals and because these actions are those which law enforcement efforts are most concerned with pre-empting, it is useful to consider those opportunities and choices that are relevant to violent action and its consequences. In doing so, it becomes possible to align 'rational' choice with 'most dangerous' choice. If the terrorist makes a mistake, his actual choice will be less dangerous than that which we have prepared to face.

Traditionally, economic analysis has tended to avoid investigating the underlying motivations of terroristic individuals, leaving that side of things to the psychologists (see Chapter 5 within this volume). Given what we have said about the difficulties experienced in the attempts to identify a set of discernible characteristics for 'the terrorist' this might have been quite wise. However, it is important to note that the boundary between economics and psychology is becoming less and less demarcated as time goes by. Over the past two decades, work in both disciplines has reflected work in the other. Akerlof and Kranton (2000) have shown that significant psychological concepts such as identity can be encompassed within traditional economic analysis. Our

economic approach is flexible enough to be adjusted for important results generated within psychology and should it one day be determined that the lone wolf terrorist is characterised by a particular set of psychological-economic-sociological features, this would be a positive development that would expand the horizons of even the most orthodox economic analysis of terrorism. This being said, we shall explore some non-orthodox models of choice emanating from behavioural economics, especially prospect theory, and the ways in which it might be relevant to the investigative process that aims to pre-empt and pursue the lone wolf terrorist.

THE DISECONOMIES OF TERRORISM

Let us begin with a discussion of a more overarching subject. That is, the place for lone wolf terrorism within the terrorism context. In fact, two prominent features of the terrorism context are consistent with each other. These two features are, on the one hand, the existence of lone wolf terrorism or terrorism at the smallest possible scale of operation and, on the other hand, the absence of evidence for economies of scale as it pertains to terrorist groups. Just as we find strong evidence for economies of scale in the tendency for business organisation to become larger in scale with independent operators and small-sized firms superseded and replaced by larger corporations (see Viner, 1932 and Lucas, 1978), we observe evidence for diseconomies of scale in the absence of this tendency within the terrorism context (Phillips 2011). The Global Terrorism Database (GTD) contains many thousands of data entries referring to terrorist groups that, with very few exceptions, never reached beyond a small number of members and supporters. During the period 2000 to 2008, there were 400 different active terrorist groups involved in some form of terrorism that inflicted injuries and fatalities. Over time many terrorist groups fade away and are replaced by others.

Table 1. Number of Terrorist Groups Involved in Acts of Violence Each Year³.

Year	Number of Groups Involved in Acts of Violence
2000	103
2001	26
2002	95
2003	26
2004	67
2005	111
2006	99
2007	99
2008	165

Within the terrorism context, there is a positive relationship between average fatalities inflicted by terrorist attacks and the variability of those fatalities over time. Variability reflects the risk to the terrorist that the actual outcome of a terrorist attack will be different, higher or lower, than that which was expected. Attacks that are expected to inflict more fatalities on average are also more risky or variable in their outcomes. In 2008, for

³ **Data Source:** Global Terrorism Database (GTD).

example, there were 106 terrorist groups which inflicted one or more fatalities. The five groups with the highest average number of fatalities across the twelve months of 2008 and five groups with a lower average number of fatalities across the twelve months of 2008 are listed in Table 2. The groups with the highest average also experienced the highest amount of variability in the outcomes of their terrorist activities. The monthly correlation between the monthly average fatalities inflicted by each group and the level of monthly standard deviation that characterised the outcomes of the group's terrorist activities was 0.90 in 2008. This relationship is reflected in the aggregate data year after year (see Appendix A).

Table 2. Average Monthly Fatalities and Risk: Terrorist Groups 2008⁴.

Terrorist Group	Average Fatalities Per Month	Risk (Standard Deviation)
Justice and Equality Movement (JEM)	12	38.527
Al-Qa`ida	5.875	14.058
Lord's Resistance Army (LRA)	5.739	10.811
Islamic State of Iraq (ISI)	7.451	10.340
Deccan Mujahideen	2.178	7.546
Caucasus Emirate	0.333	0.888
Terai Army	0.306	0.870
Madhesi People Rights Forum (MPRF)	0.250	0.866
Ogaden National Liberation Front (ONLF)	0.250	0.866
Basque Fatherland and Freedom (ETA)	0.308	0.861

The important thing about this relationship between variability or risk and the outcomes of terrorists' violent actions is that it varies considerably from terrorist group to terrorist group. Some groups 'dominate' others by inflicting a higher average number of fatalities upon civilians than other groups while experiencing a lower amount of variability (Sharpe, 1966, p. 123). The outcomes of these groups' attacks are more deadly *and* more certain. Comparing simple averages unadjusted for risk or variability overlooks this fact. A statistic that accounts for the amount of variability experienced by terrorist groups relative to the average fatalities inflicted by their attacks is the fatalities-to-variability ratio. This is the ratio of the average fatalities inflicted by a terrorist group to the variability of those fatalities across attacks over time. What we find when we analyse the fatalities-to-variability ratios for individual terrorist groups is that it is very difficult for terrorist groups to generate and maintain a relatively high fatalities-to-variability ratio over time and, in general, the fatalities-to-variability ratios of terrorist groups are quite low. For the period 2000 to 2008, the average fatalities-to-variability ratio or risk adjusted capability to inflict fatalities through an act of terrorism of the ten groups with the *highest* ratio in each year was 0.7847 fatalities per unit of variability. The majority of the 400 or more terrorist groups that were active during this time recorded much lower fatalities-to-variability ratios. The ten groups with the highest ratios in 2008 are presented in Table 3.

⁴ **Data Source:** Global Terrorism Database (GTD).

Table 3. Highest Fatalities-to-Variability Ratios, 2008, Monthly Data⁵.

Terrorist Group	Fatalities-to-Variability Ratio
Communist Party of India - Maoist (CPI-M)	1.245
Al-Qa`ida in Iraq	1.179
New People's Army (NPA)	0.990
Liberation Tigers of Tamil Eelam (LTTE)	0.928
Taliban	0.907
Revolutionary Armed Forces of Colombia (FARC)	0.863
Baloch Liberation Army (BLA)	0.726
Islamic State of Iraq (ISI)	0.721
Al-Shabaab	0.651

The lone wolf terrorist also must confront the trade-off between the average number of fatalities he can expect to inflict and the risk that the actual outcomes of his terrorist actions may be quite different from that which he expected. When terrorist operations are examined at the 'group' scale, it is found that terrorist groups find it difficult to generate and maintain a fatalities-to-variability ratio of greater than 1.00. Most groups are characterised by a ratio that is significantly lower than this and those groups that do manage to generate a higher ratio cannot do so persistently over time. At the smallest scale of terrorist operation at the level of the individual terrorist, the story is different. If the lone wolf terrorists that were active in the United States during the period 1960 to 2009 were treated as an 'unconnected group' the fatalities-to-variability ratio recorded by the group for the entire period is 0.7510, indicating that the aggregate of terrorist activity perpetrated by America's lone wolf terrorists inflicted a higher average number of fatalities per unit of variability than most of the terrorist groups contained within the GTD. This is important because terrorist groups, perhaps having recognised the diseconomies that we have been talking about, encourage individuals who share a similar ideology to participate in lone wolf terrorism (MEMRI, 2012).

The possibility that the fatalities-to-variability (or risk-reward trade-off) is more effectively managed at a smaller scale of terrorist operation is also reflected in the summary statistics for the attack method category, 'armed attacks' within the RAND-MIPT transnational terrorism database. Across the period 1968 to 2008, the average number of fatalities per 'armed attack' was 5.32 and variability (standard deviation) 15.00 fatalities per attack per year. The fatalities-to-variability ratio of 'armed attacks' was 0.3546. Many of the lone wolf terrorists who were active in the United States over the same period engaged acts of violence that would be categorised as 'armed attacks', especially shootings or shooting sprees. In 'armed attacks'—with assassinations and bombings removed from the dataset—America's lone wolf terrorists inflicted an average of 2.63 fatalities per armed attack with variability 2.87 and a fatalities-to-variability ratio of 0.9157, almost two-and-a-half times the ratio that characterises the transnational 'armed attacks' perpetrated predominantly by terrorist groups. Although the armed attacks of the lone wolf terrorists could be expected to inflict about half as many fatalities as an act of transnational (group) terrorism of the same category, the outcomes were characterised by about one-fifth the amount of variability across the different lone wolf terrorists' actions. The armed attacks perpetrated by lone wolf terrorists were fifty percent as deadly but eighty percent more certain (less variable).

⁵ **Data Source:** Calculations made using the data contained in the Global Terrorism Database (GTD).

On average, if a lone wolf terrorist is successful in engaging in an act of violence, the outcome is both more deadly and more certain than would be the case for many of the terrorist groups contained within the GTD. Both the size distribution of terrorist groups and the relative capability of the aggregate of lone wolf terrorists in the United States to inflict a level of fatality with less uncertainty than terrorist groups point towards the conclusion that the terrorism context is characterised by diseconomies of scale. If this is so and if the terrorism context reflects over time some tendency towards an optimal size distribution of terrorist operation, lone wolf terrorism may be expected to become a more prominent feature of the terrorism context. Because of the lone wolf's common modus operandi of engaging in a 'single spree of violence' governments and security agencies may be advised to view the individual lone wolf as the subject of investigation whilst viewing the aggregate of single-attack (or spree) and serial-attack lone wolves not as a disconnected set of individuals and outcomes but as an unconnected group emerging from the nature of the economies that characterise the scale at which terrorism is most optimally undertaken.

THE OPPORTUNITIES AND CHOICES OF THE LONE WOLF TERRORIST

Economics is especially well-suited to the analysis of autonomous individual choice. In fact, even when defence economists analyse terrorist groups they often make use of the 'representative agent' theoretical device which effectively treats the group as a single independent decision-maker. Even so, the lone wolf terrorist presents significant analytical challenges if we wish to push beyond a statement of the obvious—for example, that the lone wolf terrorist can be analysed within a rational choice framework where he is viewed as making his choices in a manner that maximises his expected utility—and obtain results that are relevant to policymakers and, more importantly, law enforcement and security agencies engaged in investigative processes that aim to pre-empt or pursue particular lone wolf terrorists. Because the sociological-economic-psychological characteristics of lone wolf terrorists (and terrorists in general) have yet to yield discernible and reliable patterns, abstracting from the standard constituents of a potential lone wolf 'profile', as economic analysis is predisposed to do, will not abstract from as much analytical detail as might be expected and, what is more, may open new perspectives onto lone wolf terrorist behaviour that allows us to extract more from our existing catalogue of sociological-economic-psychological characteristics than has been the case up til now.

At the most fundamental level, the economic analysis of the lone wolf terrorist would proceed by writing down an expected utility function that encompasses the particular opportunities and choices that have been deemed pertinent to the analysis. This type of approach follows Becker (1968) and Ehrlich (1973) who were among the first economists to use expected utility theory to investigate crime and criminal behaviour. Within defence economics, Landes (1978) is one of the earliest examples of an application of this traditional theoretical framework to a type of terrorist behaviour. Landes (1978) analysed hijacking. Similar approaches have been taken to the analysis of other types of terrorist activity, especially those involving negotiations or bargaining (Sandler et al., 1983, Sandler and Scott, 1987, Gaibullov and Sandler, 2009). Landes describes the opportunities and choices of the hijacker with the expected utility function:

$$EU = (1 - P_a)U(W_j) + P_a P_c U(W_i - S) + P_a (1 - P_c)U(W_j - C) \quad (1)$$

Here the hijacker's expected utility depends upon the probability of apprehension in country i , P_a , the probability (given apprehension) of being convicted and sentenced to prison, P_c , the hijacker's wealth, W_i and W_j , in each of two countries, i and j , the monetary equivalent of the sentence, S , in country i and the monetary costs, C , associated with apprehension but no sentence (example, costs of defending oneself at trial). In Landes' (1978) model, the potential hijacker's opportunities are two-fold: (1) hijack; (2) do not hijack. The potential hijacker's choice will be the one that maximises his expected utility. If the government takes steps to increase the probability of apprehension and conviction it will decrease the expected utility of hijacking and we should see a decline in the number of hijackings undertaken. Landes' (1978) empirical analysis revealed that such security initiatives as placing air marshals on flights, installing metal detectors at airports, arranging for hijackers to be extradited back to the United States and substantially increasing the prison sentences imposed on hijackers were significant in bringing about a rapid decline in the number of hijackings undertaken in the United States. On the face of it, the expected utility analysis appeared to be quite good at explaining the behaviour of potential hijackers. Given their particular objective, which was usually to obtain money or get to Cuba, hijackers had previously found that hijacking ranked higher (had a higher expected utility) than doing something else (encompassed by a broad 'do not hijack' in Landes' model). Following several steps by the U.S. government, this ranking was reversed.

All of this sort of analytical work must be careful not to fall prey to the same criticisms that have been directed at Becker's work (Blaug, 1992, especially p. 223). If we can use expected utility theory to obtain the prediction that hijacking will decrease when air marshals are put on planes, metal detectors are put in airports and harsher prison sentences are put in place and then we test that theoretical prediction empirically and find that it was indeed the case that a decrease in hijacking followed these particular security measures, have we proven anything at all? Aren't such a theory and its empirical verification somewhat banal? The line is a very fine one and Blaug (1992) points out that Becker might have crossed it in his later work, though not necessarily his work on crime and criminal behaviour. What prevents analysis like Landes' (1978) from slipping into banality is the fact that the analysis explains why we see a decline in attempted hijackings and not simply an increase in the number of hijackers being apprehended. That is, the analysis explains the 'weighing up' that potential hijackers do and predicts changes to the results of that weighing up when they are confronted with changed circumstances. When there are changes to the payoffs, potential hijackers reorder their preferences away from hijacking and do not even attempt it. It is not the case that they simply proceed as usual and get caught in greater numbers.

It is the case that the opportunities and choices of the lone wolf terrorist could be cast in terms of the 'full' expected utility analysis of the type used by Landes (1978). The analysis of the lone wolf within such a theoretical framework presents two main obstacles. First, a full expected utility analysis requires payoff and probability estimates for each outcome under consideration. Even if we concentrated on a particular attack method or target type, this would be a difficult task. Second, the individuality of the lone wolf and the absence of a clearly discernible 'archetypal' profile mean that any attempts to develop a full expected utility analysis around particular motivations, attack methods and targets (to name but a few aspects of the terrorism context)

must always verge on the boundary between pure formalism and useful analysis. Rather than a full expected utility analysis of a particular scenario, we may find it useful to concentrate our efforts on a broader set of opportunities and choices and the alternative to ‘full’ expected utility analysis called mean-variance utility analysis. One of the most important choices that the lone wolf makes is his choice of attack method. The attack method that he chooses plays a part in determining the outcomes of his terrorist actions. The most immediate outcome of terrorism is the fatalities and injuries that it inflicts on civilians. It is possible to define the opportunities and choices of the lone wolf terrorist with respect to attack methods and the fatalities and injuries expected to result from the deployment of those attack methods.

This approach depicts the lone wolf as choosing attack methods on the basis of the fatalities and injuries that he expects to inflict and the possibility that the actual outcome diverges (higher or lower) from that which he expected. Terrorists, through word and deed, have indicated their intention to inflict fatalities and injuries through violent acts. For example, the man arrested for plotting a metro bombing in Washington had told contacts that he planned to kill as many people as possible (AFP, 2010). Although the infliction of fatalities and injuries might be a subsidiary goal that is correlated with some more final goal, such as press coverage, it is clear that the actions of terrorists are designed to inflict a level of human tragedy. Furthermore, this cannot be undertaken without bearing the risk that the actual amount of human tragedy that is inflicted is less than or greater than that which was expected. If we look at attack method choice through this analytical lens, we see a much more delineated set of opportunities from which the lone wolf can choose. There are not more than ten attack method categories⁶. Each represents an opportunity to inflict human tragedy and each is attended by the risk that the actual outcomes will be different from the expected outcomes. The lone wolf weighs the different opportunities in terms of the expected outcomes and the risk that the actual outcomes will be different. The ‘full’ expected utility analysis is collapsed into an analytical framework of risk versus reward. Our rewards could be anything that conveys positive utility to a terrorist. This could be press coverage. We have chosen the immediate outcome of terrorism as the unit of analysis: fatalities and injuries.

The expected utility function that describes the lone wolf’s opportunities and choices across all attack methods is one that contains just the two moments of the distribution (mean and standard deviation) of the fatalities expected to result from a single attack method or a combination of attack methods:

$$\bar{U} = f(E_F, \sigma_F) \tag{2}$$

The lone wolf chooses his attack method (or combination of attack methods) on the basis of the fatalities that he expects to inflict and the variability of those outcomes. We must not think that the lone wolf will find it difficult to determine approximately what the possible outcomes of his actions will be. The press coverage of terrorist incidences is comprehensive and there is a significant amount of information about both successful and failed attacks embedded within such coverage that may calibrate expectations with regards to the possible outcomes of a particular type of attack. The utility function, equation (2), depicts the lone wolf as trading off expected

⁶ The RAND-MIPT database lists these as: assassination, arson, armed attacks, bombing, kidnapping, hijacking, hostage-taking, unconventional attacks, ‘other’ and ‘unknown’.

fatalities against variability. If we applied this to Landes' (1978) hijacking analysis, our expected utility analysis would be much simpler and we would not need probability estimates for each outcome. Instead of ordering his different opportunities on the basis of an expected utility computed over the probabilities of all possible outcomes and their associated utility, equation (2) says that the lone wolf will order his different opportunities (attack methods) on the basis of the expected fatalities and the variability of the possible outcomes. Both of these things are inferred from the 'averages' that the lone wolf might reasonably be expected to see reflected in the publicly available information regarding the outcomes of actual and attempted acts of terrorism. In turn, this allows our analysis to be based on historical data without the need for further inferences regarding the possible outcomes and their probabilities.

THE LONE WOLF TERRORIST'S ATTACK METHODS: OPPORTUNITIES AND CHOICES

The RAND-MIPT transnational terrorism database lists several attack method categories that encompass acts of transnational terrorism perpetrated since the late 1960s. When trying to obtain data that may be used to analyse the opportunities and choices of the lone wolf, the transnational terrorism database emerges as the most appropriate starting point. The number of lone wolf terrorists is relatively small and their attacks relatively idiosyncratic (with the notable exception of the shootings and shooting sprees). The complete historical record of terrorist incidences such as that contained within the GTD includes many attacks that are not relevant to the analysis of the lone wolf's opportunities and choices. In particular, attacks on civilians in a war-torn region such as Iraq or Afghanistan are not reflective of the outcomes that a lone wolf terrorist is likely to achieve in attacks undertaken in Western countries. So the RAND-MIPT database on transnational terrorism is the most extensive record of terrorist incidences that most accurately reflects the fatalities and injuries that a lone wolf terrorist could expect to inflict if he deploys an attack method that is encompassed within one of the attack method categories covered by the database. Each attack method category has an expected number of fatalities and injuries and each expected amount of human tragedy is accompanied by a variability that reflects the risk that the actual outcomes of such a type of attack may diverge from those which were expected.

Table 4. Attack Type, Fatalities and Variability of Outcomes⁷.

Attack Type	Average Fatalities and Injuries Per Attack Per Year	Standard Deviation
Armed Attacks	5.32	15.00
Arson	0.72	1.85
Assassination	1.54	0.71
Hostage	11.46	38.18
Bombing	5.88	6.09
Hijacking	3.91	10.82
Kidnapping	0.46	0.35
Other	1.14	3.02
Unconventional	7.48	42.94
Unknown	1.11	4.04

⁷ **Data Source:** Calculations made using the data contained in the RAND-MIPT transnational terrorism database.

When the level of analysis is 'attack method' the same statistical structure is evident as that which manifests itself in the aggregate fatalities-to-variability ratios—a positive relationship between inflicted fatalities and variability. Just like the terrorist groups whose actions populate the historical record of terrorism, the lone wolf terrorist faces a trade-off between the number of fatalities he can expect to inflict with a particular attack method and the possibility that the actual outcome will be different from his expectation. The opportunities that the lone wolf has to inflict human tragedy are contained within Table 4. In essence, these opportunities are 'pairs' of fatalities and variability. If he chooses an attack method that is expected to inflict a higher amount of human tragedy, he must bear the greater risk that his attack method will inflict more or less human tragedy than he expected. If he wants a more certain outcome, he must choose an attack method with a lower expected amount of human tragedy. Something that is particularly important to consider, though, is the case where the lone wolf terrorist can combine attack methods. This is difficult for the lone wolf terrorist to do, particularly at short horizons or, at the limit, simultaneously. A terrorist group can allocate its resources across different attack methods and deploy terrorist operatives to undertake different types of attack simultaneously. A lone wolf as a single individual cannot easily do this. However, Anders Breivik did manage to combine 'bombing' and 'armed attack', making use of a timed bombing device to enable him diversify his strategy by combining two different attack methods. When attack methods are able to be combined, a feature of the same statistical structure that is manifested in a positive fatalities-to-variability relationship emerges with a great deal of significance for the risk-reward trade-off. This feature of the statistical structure is the correlation between the fatalities generated by the different attack methods.

Because the correlation between the outcomes of the attack methods is imperfect, the terrorist may inflict more fatalities per unit of risk than law enforcement would expect if they did not take into consideration the imperfect correlation and the lone wolf's potential, though limited, ability to combine imperfectly correlated attack methods together in an overall terrorist strategy. Rather than a linear 'list' of attack methods, the lone wolf terrorist may choose from a non-linear or concave set of attack methods and combinations of attack methods. The fact that the opportunity set confronting terrorists is concave rather than linear was identified by Phillips (2009). The critically important feature of a concave set of opportunities is that the expected payoffs at each level of variability are higher than they would be if all the payoffs to the different attack methods were perfectly positively correlated. There are gains, measured in terms of higher expected payoffs per unit of variability, that are obtainable through combining two or more attack methods together. When you compute the average number of fatalities and variability for every possible combination of the attack methods listed in Table 4 and plot those attack methods or combinations that have the highest expected payoff at each level of variability, the result is a concave set.

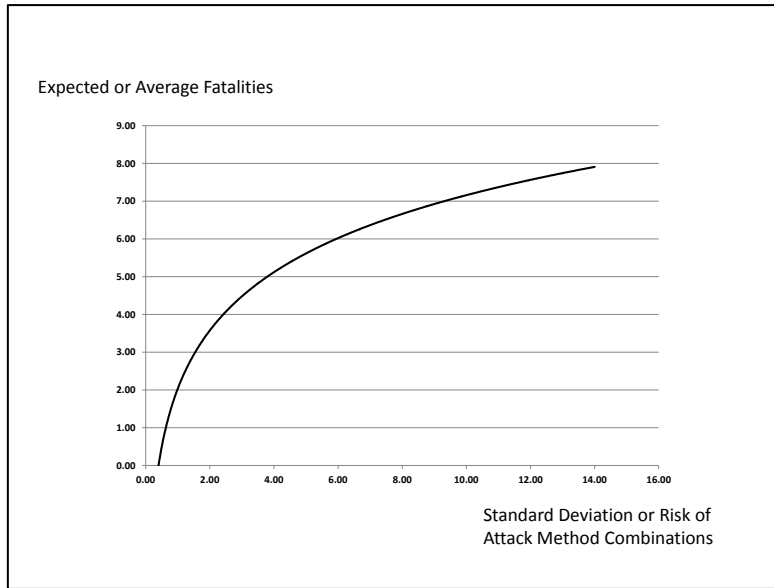


Fig. 1. The Lone Wolf's Opportunity Set (Based on RAND-MIPT Data)

An important question can now be answered with the assistance of economic analysis. When making his decision on the basis of expected fatalities and variability, in what order of preference will the lone wolf place the attack methods listed in Table 4? Which attack method (or combination of attack methods) is the lone wolf terrorist's best-ranked choice from the available opportunities? The standard approach in economics is to determine the 'optimal' or 'rational' choice or the one that maximises expected utility. This has been criticised both within and without of the economics discipline but there is reason to expect this approach to be somewhat more useful to us within the context that we have been considering. In this context, a choice from the set of attack method opportunities whose risks and payoffs are presented in Figure 1 will be the most dangerous choice. By making the fatalities that are expected to be inflicted by an act of terrorism the key variable in the terrorist's objective function, we equate the terrorist's most dangerous choice with the optimal one of economic analysis. If the terrorist errs, as well he might, he will inflict less fatalities per unit of risk than we were prepared for. This is much better than the inverse scenario where we expect the terrorist to choose sub-optimally and essentially rule out the worst possible outcomes.

Any choice from the concave set of opportunities presented in Figure 1 will be optimal in the sense that such a choice will have the highest expected number of fatalities at its particular level of risk or variability. Although the number of 'points on the line' in Figure 1 is infinite, certain attack methods and combinations of attack methods emerge as dominant optimal choices over particular ranges of the opportunity set. The range which is inhabited by the lone wolf terrorist will depend on his preference for risk. If he is more averse to risk, he will inhabit a range in the south-western region of the opportunity set, whereas if he is less averse to risk or more risk seeking he will inhabit a range in the north-eastern region of the set. In each range, particular attack methods dominate the others.

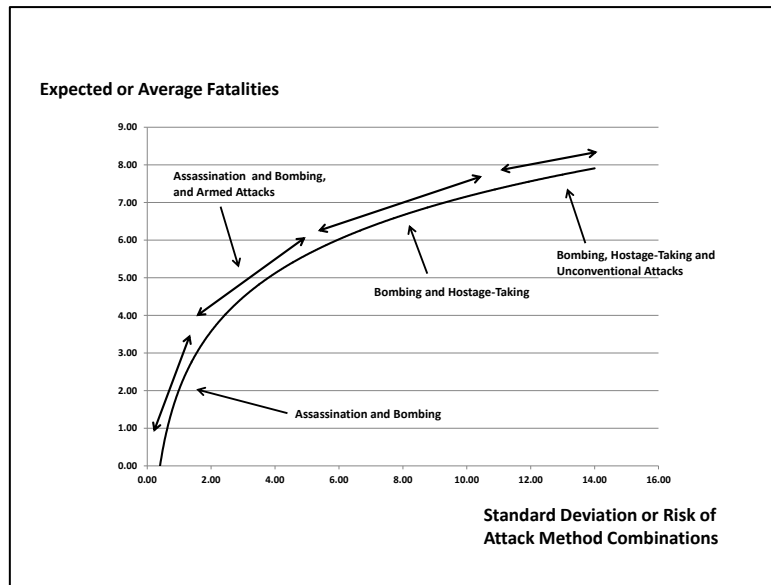


Fig. 2. Dominant Attack Methods at Different Risk Ranges.

The range that the lone wolf terrorist inhabits will depend on his risk preference. It is almost certainly the case that terrorists, including lone wolf terrorists, are risk averse rather than risk seeking. A terrorist who is averse to risk will allocate his resources to more risky terrorist attack methods only if he receives a commensurate increase in the payoffs that he can expect to yield on average. A risk seeking terrorist would allocate all of his resources to the single riskiest attack method. This type of behaviour is seldom, if ever, observed. If we take the historical record of lone wolf terrorism as our guide, we know that most lone wolf terrorists have chosen either assassination, bombing and armed attacks as their attack methods. This indicates a medium-high level of risk aversion. Although this does not rule out the possibility of the emergence of a lone wolf characterised by a much lower level of risk aversion, it does give us an indication of the risk ranges that have usually been inhabited by lone wolves in the past. The lone wolf terrorist is most likely to be a relatively risk-averse individual. When he engages in violence, his optimal attack methods choices are assassination at the highest level of risk aversion and armed attacks and bombing at medium levels of risk aversion. His expected number of fatalities per attack is no more than 7.00 but the outcomes of his attacks exhibit a relatively small amount of variability. This highlights the threat of the lone wolf. The challenge facing law enforcement is to prevent the lone wolf from striking. Once his attack commences, it is unlikely that it will end without a level of harm being inflicted upon his victims.

PURSUING THE LONE WOLF TERRORIST

The investigative process that is applied to lone wolf terrorism must address two challenges: (1) the pre-emption of the lone wolf terrorist; and (2) the pursuit of the lone wolf terrorist if he strikes and remains at large. Aspects of the economic analysis of the lone wolf terrorist may contribute to both stages of the investigative process. The pre-emption of the lone wolf is extremely challenging but it is in just such a context that even small contributions may be important. The ways in which economic analysis may be used to delineate the lone wolf's opportunities and choices provide a new perspective to the problem. It is unlikely, for example, that without economic analysis to provide such an insight that law enforcement would be aware that the terrorist's

opportunity set is characterised by higher expected payoffs per unit of variability when attack methods can be combined, though they might have had an intuition to that effect based on cumulative experience in law enforcement and the observation of the outcomes of terrorist attacks. Similarly, economic theoretical frameworks may prove to be useful in that part of the investigative process that is designed to identify, pursue and apprehend a lone wolf terrorist who has struck and who remains at large. In this case, the type of attack method that the lone wolf has chosen will provide insights into the amount of variability or risk he is willing to bear and, in turn, the type of risk aversion that most likely characterises him.

Risk preference is a fundamental and critically important part of the analysis of behaviour under conditions of risk and uncertainty. Analysis of terrorist behaviour that does not take risk preference into account will overlook many of the most important aspects of terrorist decision-making. For example, it is the conventional wisdom that concessions by the government to a terrorist group will make that terrorist group more risk seeking and more likely to engage in additional and more intense acts of violence. However, the matter is not so clear cut. Sandler et al. (1983), Atkinson et al. (1987) and Lapan and Sandler (1988) have shown that the 'never negotiate' position is not always optimal. Work on incentives structures in other parts of economics, especially Ross (2004) and attempts to bring this work within the purview of the defence economics literature (see Phillips and Pohl 2012), have shown that an increase in government concessions does not unambiguously decrease terrorist risk aversion and, in fact, might even increase it under certain conditions. The outcome depends on both the type and level of risk aversion that characterises the terrorist or terrorist group. When the lone wolf's choices are the subject of analysis, his level of risk aversion and the type of risk aversion that he exhibits are important considerations. He may be more or less risk averse. His *level* of risk aversion may be high or low. He may exhibit increasing, decreasing or constant relative risk aversion as the outcomes of his terrorist actions unfold and accumulate. His *type* of risk aversion may be increasing, decreasing and constant.

We have spoken of the lone wolf ordering his preferences on the basis of expected utility. The traditional approach in orthodox economic science is to treat this preference ordering process formally by assuming that the individual behaves as if he 'computes' the expected utility of each of his opportunities. The individual is assumed to apply his expected utility function to this process. Economics makes use of a small number of expected utility functions: quadratic, logarithmic, exponential and power. Each has different mathematical properties that reflect different ways in which risky opportunities are weighed up and choices made. Within economic science, the von Neumann-Morgenstern (NM) (1944) axioms for rational choice are accorded a good deal of significance. Preference orderings across opportunities are viewed as 'rational' if they are consistent with the NM axioms. The mean-variance expected utility analysis introduced in the previous section yields a preference order that is approximate to a full expected utility analysis but will only be guaranteed to be consistent with the NM axioms if the payoffs are distributed normally or if expected utility is quadratic. The quadratic expected utility function has a place of prominence within the development of mean-variance expected utility analysis. It should be noted, however, that a mean-variance preference ordering will approximate an ordering determined by a full expected utility analysis even when payoffs are not normally distributed and when utility is not quadratic. Much has been made of the properties of quadratic utility in some parts of the financial economics literature but it does not alter the fact that the method provides a

computationally tractable preference ordering that will approximate a full expected utility analysis which will likely be much more burdensome to compute. In any case, the quadratic utility function approximates a broader class of functions (Elton et al. 2003, p. 220).

If the lone wolf terrorist's preference ordering process can be assumed to be exactly or approximately described by a quadratic expected utility function, it follows that the lone wolf may be expected to be characterised by a particular type of risk aversion. The quadratic expected utility function may be written as:

$$U(R) = (1 + b_0)R + b_1R^2 \quad (3)$$

The utility function simply relates utility or satisfaction with whatever contributes to it, either positively or negatively. In equation (3), the terrorist's expected utility depends upon the payoffs or rewards to terrorism, R . Since R is a 'good', increases in R increase expected utility. However, variability or risk is 'bad' and increases in risk decrease expected utility (i.e. $b_1 < 0$). The quadratic utility function has several interesting properties. First, the function exhibits increasing risk aversion. As the terrorist's actions accumulate fatalities over time, he allocates less resources (including time) to terrorism. Second, and more interesting, the terrorist can become satiated within a relatively narrow range of payoffs. Satiation means that a point is reached where more of something is not preferred. In this context, past some point more fatalities are no longer preferred to less and the terrorist may drift away from terrorist activity for some period of time. For most other utility functions, more is always preferred to less and the fact that the quadratic function allows for the opposite case has been the main point of criticism directed towards it and mean-variance analysis. Of course, in the context of terrorism it would be unwise to accept uncritically a conclusion that emerged from shortcomings attending the application of the quadratic utility function to a context that was solely concerned with monetary gain (investor behaviour) and where satiation was less easy to understand.

Phillips (2011) and Phillips and Pohl (2012) discuss the case of Theodore Kaczynski (the Unabomber) with reference to mean-variance utility, the quadratic expected utility function and the tendency of the terrorist to come and go from the terrorism context as fatalities accumulate over time. Kaczynski is a prominent example of what may be called 'serial' lone wolf terrorism, which may be contrasted with 'spree' lone wolf terrorism. Unlike the 'spree' lone wolf who engages in a time-concentrated act of violence such as a shooting spree, the serial lone wolf is more akin to the serial killer in the sense that he engages and withdraws from terrorism and may continue his attacks for extended periods if he is not apprehended. Kaczynski engaged in a series of bombings over two decades. Between 1978 and 1995, Kaczynski mailed sixteen parcel and letter-bombs to various targets around the United States. In May 1978, Kaczynski apparently left a parcel in the parking lot of the University of Illinois at Chicago. On the parcel, Kaczynski had written as the return address the address of a materials engineering professor who worked at Northwestern University at Evanston, Illinois. The parcel was found and sent by mail to the return address. When the parcel was received campus police were alerted. When a campus police officer attempted to open the parcel it exploded causing minor injuries.

In each of the years 1978 to 1982, Kaczynski engaged in terrorism at least once. Following two attacks in 1982 that caused severe injuries to a secretary and a professor at Vanderbilt University (in Tennessee) and University of California (Berkeley), Kaczynski faded away and did not engage in violent terrorism for almost three years. His most deadly attacks occurred after his re-emergence in 1985. In May 1985, a graduate student at Berkeley was severely injured when he opened a parcel containing a bomb. In November, Kaczynski mailed another device to the home of biologist James McConnell in Michigan. Both McConnell and his research assistant were injured when the package was opened. The very next month, Kaczynski left a bomb in the parking lot of a computer store in Sacramento, California. The store's owner was killed. Two months later another computer store owner was severely injured by a device left in the parking lot of his store in Salt Lake City, Utah. This was Kaczynski's last attack for six years.

The Unabomber re-emerged again in 1993. Over the next three years, Kaczynski would attack four more times. On June 22 and June 24 1993, a geneticist at the University of California and a professor of computer science at Yale in New Haven, Connecticut were injured by parcels sent by Kaczynski. Almost eighteen months later, in December 1994, an advertising executive became Kaczynski's second fatality when he opened a parcel bomb that was delivered to his home. In April 1995, a timber industry lobbyist was killed when he opened a parcel addressed to the president of the California Forestry Association. In the same month, Kaczynski contacted *The New York Times*. In the letter that he sent to the newspaper, Kaczynski stated that he would cease his violent terrorist activities if the paper published his manifesto. The Unabomber Manifesto, *Industrial Society and Its Future*, was published by The New York Times and The Washington Post in 1995. Kaczynski's brother recognised the ideas contained in the manifesto as belonging to or being similar to those held by his brother. The Unabomber was arrested in April 1996 at his remote cabin in Montana.

If we were asked, before the Unabomber was identified, to list some points relevant to the unknown suspect's profile that emerge from the economic analysis of lone wolf terrorism (with risk, reward and quadratic utility) we would be able to say that the Unabomber's choice of attack method—parcel bombings—is more akin to assassination than bombing in terms of its 'targetedness'. This would place the suspect in the higher range of risk aversion and lead us to believe that he would continue to involve himself in attacks where the outcomes did not exhibit a great deal of variability. Because of the need to find low-reward-low-risk targets at which to deploy his attack methods, the suspect will need to drift from place to place and he is unlikely to be found in the vicinity of his attacks. Of course, parcel bombing is suited to such a modus operandi. As fatalities accumulate, he is likely, because of his increasing risk aversion, to allocate fewer resources to terrorism and more resources to other activities or forms of political expression. Because of his quadratic utility, he is likely to be easily satiated at intervals, especially after a series of successful attacks (or a single very successful attack). At such times, he may discontinue his involvement in terrorism, allowing 'time diversification' between terrorism and other activities to regain a semblance of balance. The 'engage and withdraw' type of serial lone wolf terrorism exemplified by Kaczynski is reflected in the types of choice behaviour embedded within our economic analysis. This, however, is never going to be a case of perfect match and economic analysis, like investigative psychology and offender profiling, will require a mixture of pragmatism and law enforcement experience in order to be effective at the operational level.

THE 'COPY CAT' LONE WOLF TERRORIST ACT

The mean-variance or risk-reward approach to analysing the opportunities and choices of the lone wolf terrorist is, because of its computable results regarding opportunities and preference orderings, more capable of yielding operationally relevant advice for law enforcement and security agencies than the more computationally burdensome full expected utility analysis. However, the mean-variance approach is still more or less orthodox from the viewpoint of those critics of economic theory and rational choice. Over the past forty years there have been significant advances in the analysis of choice from a behavioural or psychological perspective (DellaVigna, 2009). Of special note is the work of Kahneman and Tversky (1979 and 1992). Kahneman and Tversky's 'prospect theory' is an alternative to expected utility analysis in which preference orderings over 'lotteries' are determined by the application of a more complicated probability weighting scheme that accounts for many of the violations from the axioms of expected utility theory that have been observed in experimental economics laboratories.

Kahneman and Tversky (1979, p. 265) discuss a series of examples of violations of the axioms of expected utility theory in hypothetical choice scenarios. All of Kahneman and Tversky's (1979, pp. 265-271) results indicate that people do not weight the utilities of outcomes by their probabilities and therefore violate one of the principles of expected utility theory. Kahneman and Tversky's (1979) prospect theory is perhaps the most prominent of several models of choice that propose an alternative to the probability weighting scheme of orthodox expected utility theory. Other weighting schemes are discussed by Machina (1987). In attempting to develop an alternative model, Kahneman and Tversky assume that there are two phases in the choice process. First, people are assumed to edit or frame prospects so as to simplify evaluation and choice between prospects. It is during the editing or framing phase, as people grapple with the choice problem and try to simplify it, that some of the anomalies such as the 'isolation effect' are presumed to enter into the choice process. After editing, people are assumed to evaluate (rank) the prospects and choose the prospect with the highest value (utility). As such, the functional form for the preference function is non-linear:

$$V = \sum v(\Delta x_i) \pi(p_i) \quad (4)$$

In equation (5), the value V of a prospect is expressed in terms of v and π . Both v and π are scales which, respectively, (1) measures the value of deviations (gains and losses) from a reference point; and (2) associates with each probability p a decision weight $\pi(p)$ that reflects the impact of p on the overall value of the prospect (Kahneman and Tversky 1979, p.275). This setup enables the authors to assume, in light of their experimental results, that values are attached to deviations or changes from some reference point rather than to final states and that decision weights do not coincide with stated probabilities (Kahneman and Tversky 1979, p.277). As an alternative to expected utility theory, prospect theory has enjoyed significant attention in the literature (Kim et al. 2006). From the point of view of terrorism research, the 'reference point' and the relevance of 'losses' against the reference point are likely to be the most significant features of prospect theory. This has been recognised in the context of bargaining problems by Butler (2007) who explores the implications for the

outcomes of strategic bargaining interactions when players' behaviour is described by prospect theory and different reference points such as the 'status quo' are important to the players.

Another way to apply prospect theory in terrorism research is by making use of the idea that the outcomes of previous acts of terrorism may be used as reference points by terrorists contemplating a future action. This approach would be relevant to existing work undertaken by terrorism researchers that involves the analysis of situations where terrorists may be thought to reference their actions or demands against those of other terrorists, past outcomes or recent events and may complement research that has used contest theory to examine terrorist behaviour (Caruso and Schneider, 2013; Caruso and Locatelli, 2008). We might guess, for example, that a terrorist who seizes hostages may not be satisfied with a ransom of \$12 million if he knows that another terrorist group was able to extract a ransom of \$25 million during a recent comparable hostage-taking incident. Prospect theory provides a theoretical framework for the analysis of the effect of this type of consideration on the decisions of the terrorist. It may be particularly useful, as we discuss, to situations where a terrorist is driven to emulate or copy the actions of a predecessor.

'Copy cat' acts of violence are something that must be taken into consideration when assessing the threat of lone wolf terrorism. Prospect theory allows us to obtain a preference ordering over the available opportunities—attack methods—that takes into account the possibility that the potential lone wolf terrorist assesses each opportunity not on the basis of some final outcome (for example, total number of fatalities) but with reference to some specific number of fatalities recorded by a predecessor lone wolf whom he seeks to emulate. With regard to 'copy cat' acts of violence, the behaviour that is most directly relevant to acts of lone wolf terrorism, particularly when those acts take the form of sprees of violence, is the behaviour of 'school shooters'. Robertz (2007) reports that perpetrators of 'school shootings' frequently "...state a desire to do it [the spree] 'better' than their predecessors—which generally means killing even more people."

Let us consider the cases of Kaczynski, whose actions have already been detailed, and Anders Behring Breivik. In Norway in July 2011 Breivik engaged in a bombing and shooting spree that resulted in the deaths of 77 people. The attacks were undertaken in two parts. First, a car bomb was left outside the government building that housed the offices of the Prime Minister. The bomb was detonated and killed eight people. This is exactly what would be expected from an 'average' bombing attack. Breivik then travelled approximately 40 kilometres to a youth camp where he murdered another 69 people in an hour-long shooting spree. For a terrorist attack that might be categorised as an 'armed assault', 69 fatalities is many standard deviations from the mean number of fatalities historically generated in such attacks⁸. If Kaczynski is a prominent example of 'serial' lone wolf terrorism then Breivik is certainly the archetypal example of 'spree' lone wolf terrorism. The question that we wish to answer concerns the attack methods that would be chosen by an individual seeking to emulate the actions of either Kaczynski or Breivik. Prospect theory can answer this question if we determine the prospect

⁸ What might be required is some estimate of an expected number of injuries and fatalities from shooting sprees in confined locations, such as schools, campuses or youth camps. The injuries and fatalities inflicted by lone shooters (though not necessarily lone wolf terrorists) have sometimes been very substantial. The mean and standard deviation of the injuries and fatalities inflicted by such specialised armed attacks may represent the statistical foundation for a new attack method category.

value (utility) of the alternative attack methods with reference to the number of fatalities inflicted by Kaczynski and Breivik.

Although Kaczynski inflicted an accumulated total of 23 injuries and fatalities, when considered individually his attacks inflicted a single injury or fatality. A potential lone wolf who would seek to emulate Kaczynski's parcel bombing campaign may operate against a reference point of 1 or 2 for each single attack. The total injuries and fatalities inflicted by Breivik during a time-concentrated spree were 228. We seek to determine how a potential lone wolf seeking to emulate the actions of either Kaczynski or Breivik would order his preferences over the attack methods encompassed by the RAND-MIPT attack method categories. This analysis involves computing the prospect values for each attack method using 1, 2, 23 and 228 as reference points. Using the mean and standard deviation (Table 4) and assuming a normal distribution, the probabilities and the cumulative probabilities for each number of injuries and fatalities per attack per year are computed for each attack method⁹. Each of the probabilities are then weighted to find $\pi(p_i)$. Using a particular reference point, the change in x is computed for each level of injury and fatality. If, for example, the reference point is 3, then the change in x for 2 injuries and fatalities is -1 . The result is a set of values for the various changes in x (above and below the reference point). The final step is multiply each of these values by the weighted probabilities as in equation (5) and sum to find the value or utility of the prospect.

The preference orderings, based on prospect value, that emerge from the analysis are presented in Table 5 below. The prospect values are 'reference point dependent' and the preference ordering changes depending on how the potential lone wolf references his attacks. If he were to reference his attacks to Kaczynski, we should expect him to choose either assassination or bombing (if those opportunities are available to him). On the other hand, if he references his attacks to Breivik, we should expect him to choose either bombing or armed attacks. This type of analysis may prove useful to the investigative process in cases where law enforcement believes there is a chance that a predecessor lone wolf's actions may be emulated by an unknown suspect. For example, a suspect, who may be identified or unidentified, is known to be obsessed with the actions of a predecessor lone wolf. Under these conditions, if the suspect's decision making is described by prospect theory¹⁰ and the predecessor's outcomes are a salient reference point, prospect theory may provide some indication to law enforcement about the value or utility that the suspect may attach to particular attack methods. This may help to guide an investigation or the security initiatives undertaken by local law enforcement at potential targets.

⁹ The normality assumption is not as unjustifiable as it might seem. The data series we are considering is injuries and fatalities per attack per year not the 'raw' series of injuries and fatalities per year.

¹⁰ It may not be. That is why contributions from orthodox expected utility theory and mean-variance expected utility should be used in conjunction with each other to sketch several possible profiles for each offender.

Table 5. Preference Orderings by Prospect Value: Highest to Lowest.

Reference Point = 1 Fatality	Reference Point = 2 Fatalities	Reference Point = 23 Injuries and Fatalities	Reference Point = 228 Injuries and Fatalities
Assassination	Bombing	Bombing	Bombing
Bombing	Assassination	Armed Attacks	Armed Attacks
Kidnapping	Hijacking	Hijacking	Hijacking
Arson	Armed Attacks	Hostage	Hostage
Hijacking	Hostage	Unconventional	Unconventional
Armed Attacks	Arson	'Miscellaneous'	'Miscellaneous'
Hostage	'Miscellaneous'	Arson	Arson
'Miscellaneous'	Unconventional	Assassination	Assassination
Unconventional	Kidnapping	Kidnapping	Kidnapping

CONCLUDING REMARKS

Economics is about opportunities and choices. Economic analysis first of all delineates some set of opportunities from which the terrorist or terrorist group chooses and then proceeds to the analysis of the choice that is made from the opportunity set. Usually, this choice is the 'rational' or expected utility maximising choice but sub-optimal choices are implicit within the delineated set of opportunities and these possible choices are not ignored. Indeed, there is nothing within economic analysis to say that the decision-maker always makes a perfect decision based on a complete calculation and weighing up of alternatives. However, it is easy to see why 'rational choice' is the target of criticism. It is not always clear how it is relevant to actual decisions even if it is accepted that the 'rational choice' is a benchmark against which actual choices might be compared. This problem is mitigated considerably if we equate the rational choice with something meaningful and significant. Although we may have chosen any relevant payoff, we chose to analyse terrorist opportunities and choices from within a context where the fatalities inflicted by different attack methods are the main consideration of terrorist decision-maker. In such a context the set of rational or expected utility maximising opportunities is equivalent to the most damaging or dangerous opportunities. If we prepare, in this context, for a lone wolf who chooses optimally or rationally from his set of opportunities we are preparing for a lone wolf to choose the most deadly attack method combinations. It would seem unwise to forgo an analysis of these most dangerous opportunities on the basis of an ideological conclusion that 'terrorists do not choose rationally' and would therefore not choose them.

Economic analysis in general may provide some insights into the terrorist's logic of choice but it is economic analysis that provides or is based upon quantitative computable results that will be most effectively used in the investigative process. It is no good knowing that the terrorist chooses optimally (or not) unless we can at least narrow down his opportunities and choices. To do this necessitates a certain willingness to abstract from certain details and focus on a few key features of terrorism context. Our analysis focuses on a small list of key features: attack methods, expected fatalities and the risk that the actual outcome may diverge from that which was expected. Rather than try to figure out how the terrorist would order his attack method preferences if he were to apply a full expected utility analysis and weigh up all the payoffs and all the probabilities, we try to determine

how the terrorist would order his attack method preferences if he makes an assessment of risk and reward. Terrorists could make such an assessment simply on the basis of what they see reported about different attacks. Such an analysis opens the way for a delineation of the terrorist's opportunities as a set of risk-reward 'pairs' rather than a more complex amalgam of different characteristics. Furthermore, we can define the set of opportunities that dominate all others in terms of reward per unit of risk. A utility maximising terrorist would choose from this sub-set. His choice depends on his preference for risk. We can identify the attack methods that would be chosen by terrorists who are more risk averse as well as those that would be chosen by more risk seeking terrorists. Some attack methods, such as arson, are all but ruled out and are dominated by other attack methods at each level of risk.

If we are willing to attach a particular expected utility function (and risk aversion parameter) to a lone wolf terrorist we can determine the terrorist's utility maximising attack method choice with precision. However, attack methods are dominant over large enough ranges of the opportunity set to enable us to draw conclusions about the choices that would be made by particular types of terrorists without the need to make additional assumptions. At the lowest levels of risk and the highest levels of risk aversion, the lone wolf terrorist would choose assassination or a combination of assassination and bombing. At the highest levels of risk and the lowest levels of risk aversion, the lone wolf terrorist would choose 'unconventional attacks' or a combination of hostage-taking, unconventional attacks and bombing. What is most interesting about the opportunities available to the lone wolf is the concavity of the trade-off between risk and reward. This property of the opportunity set emerges from the imperfect correlations that characterise the payoffs to the different attack types and must not be overlooked by law enforcement for the simple reason that concavity implies higher average fatalities at each level of variability when compared to a linear non-concave opportunity set.

When we turn our attention to the operational details of the investigative process we find that an economic analysis of opportunities and choices can be used to generate inferences about a lone wolf terrorist who has struck and who remains at large. The attack method that the lone wolf chose reveals something about him. Among other things, it reveals his preference for risk. If he has chosen an attack method that is characterised by a relatively lower variability of payoffs we may infer that he is more averse to risk. Further inferences flow, including the inference that he will not be found in the vicinity of his targets and that he will drift from location to location in order to continue his habitation of the low-risk-low-payoff sector of the opportunity set¹¹. Similar pieces of investigative advice emerge from the application of behavioural economics, especially prospect theory, to the analysis of terrorism and terrorist behaviour. It cannot be ruled out that a potential lone wolf will be driven to copy the actions of a predecessor. If the predecessor's actions become a reference point for the potential lone wolf, we may use prospect theory to determine how the potential lone wolf will order his preferences over the available attack methods in his act of emulation. In this way, economic analysis may contribute to the investigative process. When stripped to its barest fundamental features, economic analysis is

¹¹ This is distinct from actions taken to avoid being apprehended. If law enforcement efforts have been enhanced, the average payoff may be expected to have fallen and the risk-reward trade-off will no longer be appropriate. The lone wolf might need to move to another type of attack or another type of location in order to obtain his desired risk-reward trade-off.

about opportunities and choices. Along with other analytical approaches, economic science can contribute to the investigative process designed to pre-empt or pursue the lone wolf terrorist.

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APPENDIX A

Figure A.1 Average Fatalities and Variability: All Active Terrorist Groups 2000 to 2007

