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PROSPECT THEORY AND TERRORIST CHOICE

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We study terrorist choice from the perspective of economics and psychology. Using RAND-MIPT data about the injuries and fatalities inflicted by different terrorist attack methods, we compute sets of preference orderings over the attack methods using prospect theory. This incorporates reference point dependence, risk seeking in the domain of losses, risk aversion in the domain of gains, non-linear preferences and loss aversion into an analysis of terrorist behaviour. We pay particular attention to the importance of a reference point in the context of 'copycat' acts of violence and the influence of loss aversion on the choice of attack method. Our results provide an indication of the types of attack methods that would be chosen by a terrorist whose decision-making process is described by prospect theory and who might, for example, seek to emulate or surpass the actions of a predecessor.

I. Introduction

'Terrorism studies' is a multidisciplinary research program encompassing economics (Landes 1978, Sandler et al. 1983, Im et al. 1987, Enders et al. 1992, Enders and Sandler 2002, Frey and Leuchinger 2003, Sandler and Arce 2003, Sandler and Enders 2004, Siqueira and Sandler 2006, Barros, Proenca, Faria and Gil-Alana 2007, Llussa and Tavares 2008, Phillips 2009, Brandt and Sandler 2010, Schneider et al. 2010, Kollias et al. 2011; Freytag et al. 2011 Kis-Katos et al. 2011, Santifort, Sandler and Brandt 2013), psychology (Victoroff 2005), sociology (Turk

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2004), critical studies (Jarvis 2009) and political science (Crenshaw 1981, Pape 2003 and 2005, Cronin 2006, Hoffman 2006 and Abrahms 2006, 2008, 2011). Recent surveys of the economic analysis of terrorism have been undertaken by Intriligator (2010) and Sandler (2011). The theoretical foundations of the economic analysis of terrorist behaviour can be found in the applications of expected utility theory to criminal behaviour in work undertaken by Becker (1968) and Ehrlich (1973).

Kahneman and Tversky (1979; 1992) challenged expected utility theory but their prospect theory has not been widely applied to the analysis of terrorist behaviour. Butler (2007) studies coercive bargaining in the domain of international relations in one of the few formal analyses to use prospect theory in a field that broadly encompasses the types of problems that motivate the present paper. Prospect theory may yield alternative results from the standard models that have been applied in particular cases. This is supported by the finding of important qualifications to the conclusions that are reached when strategic bargaining problems are approached from an expected value maximisation perspective—such as the model presented by Fearon (1995)—rather than a prospect theory perspective (Butler 2007).[1] Part of the justification Butler (2007) provides for his study is the paucity of applications of prospect theory to international conflict and the tendency of existing applications to draw on just one or two prospect theoretical concepts rather than developing a more complete application of the theory.

Similarly, the economic analysis of terrorist behaviour has only occasionally drawn upon prospect theory concepts such as loss aversion and has not fully worked out 'prospect values' associated with different terrorist choices and the implications of those values for the outcomes of the terrorist decision-making process. Although the utilisation of prospect theory to generate alternative sets of results that complement those obtained by orthodox approaches represents an important step, the primary advantage of an application of prospect theory to terrorist choice would appear to lie in the development of new insights into those aspects of terrorist behaviour where there is a correspondence between the structure of terrorist decision-making and the structure of prospect theory. For example, if a terrorist knows that a ransom of $10 million was recently paid for the

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[1] O'Neill (2001) presents a discussion of the treatment of risk aversion within international relations theory that contributes the background to this discussion.

release of hostages, he may feel as though he has made a loss when he is offered $1 million for the release of his hostages. In scenarios such as this where a reference point is important, it is by an application of prospect theory that we might learn more about terrorist decision-making.

Our application of prospect theory focuses on the choice of attack method with reference points centred on the injuries and fatalities that are expected to result when that attack method is used in an act of terrorism. This application allows us to compute a set of preference orderings over the different attack method categories identified by the RAND-MIPT database. In contrast to preference orderings that might be constructed on the basis of a full expected utility theory or mean-variance expected utility theory, the orderings that we construct over the RAND-MIPT attack method categories are evaluations based on a prospect value computed on the basis of expected gains and losses from particular reference points. We have chosen to apply the analysis to a particular type of violent behaviour. This behaviour is 'copycat' acts of terrorism where the terrorist seeks to emulate or surpass the level of violence inflicted by a predecessor.

Copycat acts of violent behaviour represent an important challenge to law enforcement and security agencies. For example, the stabbing murder of a British soldier in London was followed in the same week by a stabbing attack on a French soldier in Paris. The parallels between the two attacks led French authorities to investigate the possibility that the second attack was a 'copycat' act of violence rather than an independently premeditated action.[2] This type of behaviour reaches its nadir when the copycat seeks not just to repeat the symbolism or method of a previous attack but its outcomes. What is more, copycat acts of violence that involve an offender attempting to emulate a predecessor may be mixed with a desire to exceed or surpass the amount of human tragedy inflicted by the predecessor. This type of motivation has been uncovered in investigations of 'school shootings'. 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." Our approach provides a starting point for the analysis of this type of behaviour within a terrorism context.

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[2] BBC News, 25th of May, 2013.

Although the focus of our analysis is on the individual or lone wolf offender there is evidence that the actions and choices of terrorist groups are undertaken with reference to other groups' actions. The type of competitive behaviour identified by Caruso and Schneider (2013) is one example. Additional evidence comes from the narratives provided by former terrorist group members. For example, the Red Army Faction (RAF), which was active in Germany in the 1970s until the early 1990s, operated at a similar time to the "Bewegung 2. Juni" (B2J)—the Movement of the Second of June (della Porta 1995: 99-101). The literature indicates varying degrees of competition between the RAF and the B2J (see Baumann cited in Wunschik 2006: 542, Peters 2008: 321, Winkler 2007: 246, 247) and it is not surprising to find that actions by the RAF were at least partially 'referenced' to comparative actions by the B2J and other terrorist groups. An interview conducted with Stefan Wisniewski, an active member of the RAF, provides insights on the salience of reference points for the choices of the RAF. In 1978, Stefan Wisniewski was charged and sentenced to life in prison for participation in the RAF kidnapping and murder of Hanns-Martin Schleyer, President of the German Employers' Association, in 1977. In an interview conducted in an Aachen prison in 1997, Wisniewski makes several remarks which clearly point towards terrorists using their own previous actions and those of other terrorist groups as reference points in the planning and execution of future actions. Of particular interest is the comment made by Wisniewski that the B2J kidnapping of Lorenz in 1975 indicated a scale or proportion of action of which the RAF took note:

> *Am Augenmaß der Bewegung 2. Juni (im Bezug auf die Lorenz-Entführung) hätten wir uns ruhig ein Beispiel nehmen können.*
> – We could have learned a lesson from the sense of proportion displayed by the Movement 2 June (in the Lorenz-kidnapping) (Wisniewski 1997: 36, translation by the authors).[3]

The RAF later kidnapped Hans-Martin Schleyer, an action that also involved the RAF trying to 'force the government's hand' during negotiations over Schleyer

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[3] Proportion here refers to the 'magnitude' or 'scale' of the effect of the terrorist action. RAF members decided that their next action had to be 'bigger' than the kidnapping of Lorenz (Winkler 2007: 252).

by hijacking a German plane with 80 passengers on board with the assistance of members of the Popular Front for the Liberation of Palestine (PFLP). The hijacking was also conceived with reference to the actions of other groups, especially the Japanese Red Army Faction. As Wisniewski says:

> *Wir dachten dabei auch an die fast gleichzeitig erfolgreich durchgeführte Entführung eines japanischen Flugzeugs durch die japanische Rote Armee*. – We also thought of the almost simultaneously successful execution of the hijacking of a Japanese plane by the Japanese Red Army (Wisniewski 1997: 50, translation by the authors).[4]

We use cumulative prospect theory developed by Tversky and Kahneman (1992) to examine 'referenced' decision making in a terrorism context. Using the injuries and fatalities that have been inflicted in attacks perpetrated by 'predecessor' lone wolf terrorists as reference points, we apply the evaluation function from cumulative prospect theory to the RAND-MIPT attack method categories. The RAND-MIPT data on inflicted fatalities and injuries for each attack method for the period 1968 to 2007 underlies the analysis and provides the basis for the computation of the probabilities that are to be associated with each possible outcome. As explained in a subsequent section, the evaluation function of cumulative prospect theory involves computing the weighted value of each possible outcome. The value or utility of a prospect is a function of gains and losses from a reference point that each outcome represents weighted by a 'decision weight' that is an increasing function of the associated probability. This process requires the values of several parameters. We use estimates for these parameters provided by Tversky and Kahneman (1992). The results yield prospect values for each attack method category across a range of relevant reference points. These results allow us to determine preference orderings of attack methods at different reference points based on the computed prospect values.

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[4] Another terror group on friendly terms with the Palestinians, i.e. the Japanese Red Army, successfully hijacks a Japanese aircraft on 28 September 1977. On the first day of the event the Japanese government gives in to the demands of the hijackers: 9 Japanese Red Army group members are released from prison and 6 million dollars paid in ransom. Algeria, one of the possible "countries of choice" for RAF prisoners to be exchanged for Schleyer, agrees to accept all released Japanese Red Army prisoners (Winkler 2007: 330).

In Section II we present a brief outline of cumulative prospect theory. We then commence the analysis in Section III with an investigation of the behaviour of a lone wolf terrorist who may base his choice of attack method on the outcomes of the attacks of a 'predecessor' or 'reference point' lone wolf terrorist. This allows us to explore the issue of copycat acts of violence from a prospect theory perspective within the context of lone wolf terrorism. In Section IV we determine preference orderings over the RAND-MIPT attack method categories by computing the prospect value for each attack method at a number of different reference points. We reach conclusions regarding the type of attack method that might sit highest on the preference ordering of a prospective lone wolf terrorist whose decision-making process is described by prospect theory and who references his actions against the outcomes of attacks undertaken by a predecessor lone wolf terrorist. We conclude the paper with Section V.

II. The development of prospect theory

It is possible to determine preference orderings across important choice variables such as attack method, target type, attack time and attack location. One way to obtain a preference ordering over a particular choice variable is to apply expected utility theory. Landes (1978), for example, determines a preference ordering over two alternative opportunities: (1) 'hijack'; and (2) 'not hijack'. Sandler et al. (1983) determine an implicit preference ordering over negotiation-based demands. Phillips (2009; 2011; 2013) and Phillips and Pohl (2012) determine a preference ordering across different attack methods on the basis of their 'risk' (variance) and 'reward' (average outcome). If the axioms of expected utility theory are violated it is possible that the preference orderings determined utilising an expected utility theoretical framework may not accurately reflect the preferences of terrorists. Alternatives or opportunities that are analytically determined to sit at the top of the preference ordering may actually be accorded a lower ranking by the terrorist and vice versa.

Kahneman and Tversky (1979: 265) discuss a series of examples of violations of the axioms of expected utility theory in hypothetical choice scenarios.[5] Kahneman

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[5] Sometimes, these violations are called 'paradoxes'. These include the 'certainty effect' and the 'isolation effect'.

and Tversky (1979: 265-271) found that people do not weight the utilities of outcomes by their probabilities, one of the principles of expected utility theory. Kahneman and Tversky (1979) propose an alternative to the probability weighting scheme of orthodox expected utility theory. 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 contend with the choice problem and try to simplify it, that some of the 'paradoxes' 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). The functional form for the preference function is non-linear:

$$V = \sum v(\Delta x_i)\,\pi(p_i)\,, \tag{1}$$

The value V of a prospect is expressed in terms of v and π. Both v and π are scales which, respectively, measure the value of deviations (gains and losses) from a reference point; and associate 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: 275). Values are attached to deviations or changes from some reference point rather than to final states and decision weights do not coincide with stated probabilities (Kahneman and Tversky 1979: 277). In order to account for their experimental results, particularly risk aversion in the domain of gains and risk seeking in the domain of losses, a value function must be concave above the reference point and convex below it. For an outcome x, $v''(x) < 0$ for $x > 0$ and $v''(x) > 0$ for $x < 0$. The result is a value or utility function that is S-shaped around some reference point.

Once the values or utilities of the outcomes are determined they must be weighted. In expected utility theory, the weights are the probabilities. In prospect theory, the weighting scheme is more complicated and is designed to take into account the various experimental results observed to conflict with the axioms of expected utility theory. In prospect theory, the decision weights, π, are not probabilities, p, but they are an increasing function of the probabilities. At the two extremes: (1) impossible, $p = 0$; and (2) certain $p = 1$, $\pi(p) = 0$ *and* $\pi(p) = 1$. In between, the decision weights are an increasing but not one-for-one function of the probabilities. In fact, in order to account for the experimental results, the decision weights will normally be smaller than the associated probabilities: $0 < p$

< 1, $\pi(p) + \pi(1 - p) < 1$ (Kahneman and Tversky 1979: 281). Together with the value function, the weighting function produces a preference ordering based on the value, V, of the prospects being considered.[6]

In response to their critics who had pointed out important problems with the original specification of prospect theory, especially the potential for preference orderings to violate stochastic dominance, Tversky and Kahneman (1992) developed cumulative prospect theory. This version of prospect theory transforms cumulative rather than individual probabilities and ensures that stochastic dominance is satisfied. The updated version of prospect theory deals with both uncertain and risky prospects and can be applied to prospects *with any number of outcomes* (Tversky and Kahneman 1992: 298-300). In keeping with the original design of the model, people are assumed to edit or frame their choices and then evaluate them. The evaluation function of cumulative prospect theory may be stated as in equation (1) with newly developed functions for value and weighting:

$$v(\Delta x) = \begin{cases} v(\Delta x)^\alpha & \Delta x \geq 0 \\ -\lambda(-\Delta x)^\beta & \Delta x < 0 \end{cases}, \tag{2}$$

$$\pi_i = \begin{cases} \pi_i^- = w^-(p_1 + \cdots + p_i) - w^-(p_1 + \cdots + p_{i-1}) & \Delta x < 0 \\ \pi_i^+ = w^+(p_i + \cdots + p_N) - w^+(p_{i+1} + \cdots + p_N) & \Delta x \geq 0 \end{cases}, \tag{3}$$

$$:= \begin{cases} w^+(p) := \dfrac{(p)^\gamma}{(p^\gamma + (1-p)^\gamma)^{1/\gamma}} & \Delta x \geq 0 \\ w^-(p) := \dfrac{(p)^\delta}{(p^\delta + (1-p)^\delta)^{1/\delta}} & \Delta x < 0 \end{cases}, \tag{4}$$

The values for the parameters, α, β and λ are inferred or obtained from empirical or experimental evidence. According to Tversky and Kahneman (1992: 311) values are 0.88 for α and β, 2.25 for λ, 0.69 for δ, and 0.61 for γ. Although these values

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[6] "As in expected utility theory we assign to each prospect f a number $V(f)$ such that f is preferred to or indifferent to g iff $V(f) \geq V(g)$" (Tversky and Kahneman 1992: 300).

are accepted and used in empirical and experimental analysis, it must be noted that there are often large cross-study differences between experiments (Pesendorfer 2006: 717). This implies that experimental results cannot be used to 'calibrate' utility functions used in different contexts. The values for the parameters α, β and λ determined by Tversky and Kahneman (1992) may therefore not have much meaning outside of the context of their particular experimental design. Kahneman and Tversky (1979) and Tversky and Kahneman (1992) counter this criticism by highlighting the systematic nature of departures from expected utility theory. We would note that if behavioural economics and its dominant models are to be used to analyse terrorist behaviour, it is an important task for future research to determine the values of these parameters within each terrorism context.

III. 'Predecessor' or 'reference point' lone wolf terrorists

Because prospect theory identifies reference dependence as an important component of the decision-making process, it lends itself to the analysis of 'copycat' or 'referenced' behaviour. In the United States approximately 30 individuals have been classified as lone wolf terrorists since the late 1960s.[7] Despite this relatively low number, lone wolf terrorists have generally dominated the share of inflicted injuries and fatalities in recent decades. During the 1970s, there were 174 fatalities attributable to acts of terrorism in the United States. Only 11—6 percent—of these fatalities were victims of lone wolf terrorism. In the 1980s, 45 fatalities were attributed to acts of terrorism. In that decade, 12—26 percent—were victims of lone wolf terrorism. In the 1990s, lone wolf terrorists or individuals with loose affiliations, in particular Timothy McVeigh, accounted for 191—80 percent— of victims. The historical record of terrorism in the 2000s is dominated by the September 11 2001 attacks but lone wolf terrorists were responsible for 27—72 percent—of the 37 fatalities attributable to acts of terrorism other than the 9/11 attacks during the period 2000 to 2013.[8] Although only 1.28 percent of all terrorist

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[7] It should be noted that details, including the number of victims and motivation of the offender, remain unclear in some cases.
[8] This data is sourced from the Global Terrorism Database (GTD).

incidences between 1968 and 2007 were lone wolf attacks, 26 percent of victims of terrorism during that period were victims of lone wolf terrorism (Spaaij 2010: 859-860).

Lone wolf terrorism in America may be depicted as outbursts of violent extremist behaviour. The types of extremist motivations have included racism, religion, environmental politics and violent anti-abortion activism. Because perceptions of terrorism can be shaped by recent events it is important to note that only 22 of 318 acts of terrorism carried out in the United States between 1980 and 2005 were attributable to Islamic extremists (Webster Commission 2012: 6).[9] Lone wolf terrorists who carried out attacks on abortion clinics and staff and the number of injuries and fatalities they inflicted are Michael Griffin (1), Rachelle Shannon (1), Paul J. Hill (3), John Salvi (7), James C. Kopp (1) and Scott Roeder(1).[10] Lone wolf terrorists who accumulated victims in serial attacks over time are Byron De La Beckwith (1), Neal Long (17), Joseph Paul Franklin (23), Joseph Christopher (12) and Frank Spisak Jr. (5). The largest category is that which contains the spree shooters or lone wolf terrorists who inflicted multiple injuries and fatalities in time-concentrated acts of violence. These individuals are: Mark Essex (22), Mir Aimal Kansi (5), Colin Ferguson (25), Rashid Baz (3), Larry Shoemake (12), Ali Hasan Abu Kamal (8), Buford Furrow (6), Ronald Taylor (5), Richard Bauhammers (6), Hesham Mohamed Ali Hadayet (6), Naveed Afzal Haq (6) and Nidal Malik Hasan (55). Lastly, there are the lone wolf terrorist bombers. These individuals are George Metesky (15), Muharem Kurbegovich (38), Theodore Kaczynski (26), Walter Leroy Moody Jr. (2) and Eric Rudolph (153).

Across the history of American lone wolf terrorism the average (mean) number of injuries and fatalities inflicted by each lone wolf terrorist in the United States is 14.64 injuries and fatalities.[11] By comparison, lone wolf terrorists in Europe have, in general, inflicted far fewer injuries and fatalities per attack than their counterparts in the United States.[12] Across 38 incidences of lone wolf terrorism in

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[9] That is all terrorism, including lone wolf terrorism.
[10] The victim, Dr George Tiller, who on this occasion was fatally shot by Roeder in 2009, was also the victim of the attempted murder perpetrated by Rachelle Shannon in 1993.
[11] The standard deviation is 28.66. For the 'spree shooter' category the mean injuries and fatalities is 13.33 but the standard deviation is much lower at 15.14.
[12] Instituut voor Veiligheids en Crisismanagement (2007).

Europe between 1968 and 2007, those lone terrorists who inflicted more than one injury or fatality included 'The Italian Unabomber' who injured 7 people between 2000 and 2005, Guillem G.B. who injured 2 people in Spain in 2002, Franz Fuchs who killed 4 and injured 15 in Austria in the 1990s, David Copeland who killed 3 and injured 129 in England in 1999 and an unidentified assailant who killed 1 and injured 4 in an armed attack on a salon in Germany in 2000. Anders Behring Breivik combined bombing and armed attack (shooting spree) in Norway in 2011. He inflicted 77 fatalities and injured 151. These outcomes of terrorist actions perpetrated by predecessor lone wolf terrorists may become the reference points in the choices of potential lone wolf terrorists who seek to emulate a particular predecessor.

IV. Preference orderings of attack methods

The predecessor lone wolf terrorists provide reference points that range from a single injury or fatality (offenders such as Griffin, Shannon and Roeder) to 228 injuries and fatalities (Breivik). These values may be relevant to a potential lone wolf terrorist who uses the outcomes of the terrorist actions of a predecessor as a reference point in evaluating and ranking alternative attack methods that he will potentially deploy. We use prospect theory to determine the preference ordering over the available attack methods for a prospective lone wolf terrorist whose decision making is described by prospect theory and who uses the outcomes of the actions of a predecessor lone wolf as his reference point when choosing an attack method. The attack methods from which the lone wolf terrorist may choose are those encompassed by the RAND-MIPT attack method categories: armed attacks, arson, assassination, hostage-taking, bombing, hijacking, kidnapping and unconventional attacks. The data that were used in this analysis are the RAND-MIPT historical record of injuries and fatalities associated with incidences of transnational terrorism for the period 1967 to 2007. This serves two purposes. First, it provides a dataset that sits beyond the sample—lone wolf behaviour—being considered. Second, it provides a lengthy and comprehensive dataset on which to base an estimation of the likelihood that a level of injury and fatality will result from the use of a particular attack method.

Using this data, preference orderings across these attack methods can be obtained by applying equations (1), (2), (3) and (4). Assuming that the injuries and fatalities inflicted per attack per year follow either a normal distribution or a log normal distribution, the probabilities for each number of injuries and fatalities per attack were computed for each attack method.[13] The weights to be applied to the probabilities are determined using equations (3) and (4). 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. These changes in x are subject to the parameters λ, α and β as in equation (2). The result is a set of values for the various changes in x above and below the reference point which are weighted and summed to find the value of the prospect. In this case, the prospect is an attack method. The value of the prospect varies depending on the reference point number of injuries and fatalities. The preference orderings that emerge when each attack method category is ranked on the basis of its prospect value are presented in Table 1 (normal distribution) and Table 2 (log normal distribution) for prospective lone wolf terrorists with reference points of 1, 2, 3, 4 or 5 injuries and fatalities.

We commence with a discussion of the choices predicted by prospect theory for a lone wolf terrorist with a reference point of a single injury or fatality. An offender with a reference point of one injury or fatality may reference the outcomes of attacks perpetrated by predecessor lone wolf terrorists whose attack method of choice was a targeted type of attack method such that it falls within the RAND-MIPT category 'assassination'. Although there are attack methods that might be expected to inflict a higher number of injuries and fatalities, the variability of the outcomes increases as the expected number of injuries and fatalities increases. We should expect targeted or focused attack methods—those for which the expected number of inflicted fatalities is lower but less variable—to sit higher in the preference ordering when the lone wolf terrorist has a reference point that is low. Prospect theory provides a theoretical explanation for this behaviour. Prospect theory depicts the decision-maker as being risk averse in the domain of gains. At lower reference points, it is quite likely that the number of injuries and

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[13] The log normal distribution might be suitable in a context where the number of inflicted injuries and fatalities cannot be less than zero. For the normal distribution we gather the probabilities for negative outcomes under the 'zero' injuries and fatalities outcome.

fatalities inflicted by an attack will match or exceed the reference point. The lone wolf terrorist with a low reference point confronts a wide domain of gains and is expected to choose in a manner that reflects a higher degree of risk aversion.

The prospect values reflect an assessment of the outcome of the attack and the risk that the outcome will diverge from that which was expected by a decision-maker whose choices are shaped by an interaction between reference dependence, risk-seeking below the reference point, risk aversion above the reference point and loss aversion. For a reference point of a single injury or fatality, the 'assassination' attack method category is ranked highest when outcomes are assumed to be either normally or log-normally distributed. This would lead us to expect that those lone wolf terrorists seeking to target a particular individual are most likely to select an assassination-type attack rather than an attack method that could possibly inflict harm upon a particular individual *and* a number of others but only at the cost of introducing more uncertainty. Byron de la Beckwith, Michael Griffin, Rachelle Shannon and James Kopp are lone offenders who targeted particular individuals. These individuals chose attack methods that may be categorised as targeted or assassination-type attacks. In each case, the outcome of the attack was the injury or death of a single victim. The analysis leads us to expect prospective lone wolf terrorists who reference their actions against these offenders and aim to inflict a single injury or fatality to choose a targeted attack method characterised by less variable outcomes just as Byron de la Beckwith, Michael Griffin, Rachelle Shannon and James C. Kopp chose to do for their attacks.

With 2 and 3 injuries and fatalities as reference points, the prospect value of each attack method changes and a new preference ordering of the attack methods emerges. Although its prospect value falls, assassination remains atop the preference ordering computed with log-normal probabilities but it is replaced by bombing when outcomes are assumed to be normally distributed. When the reference point changes from 1 to 2, bombing, armed attacks and unconventional attacks all move higher in the preference ordering. When the reference point is increased again from 2 to 3, a similar re-ordering is observed. With each increase in the reference point, the attack methods that are expected to inflict a higher number of fatalities move higher in the preference ordering. However, the terrorist does not simply choose the attack method with the highest expected fatalities. Reference point dependence, risk seeking, risk aversion and loss aversion interact to produce a preference ordering that continues to accord relatively low rankings to the attack methods with the most variable outcomes, hostage-taking and unconventional attacks.

Table 1. Prospect values and preference rankings (normal distribution)

Attack method category	Reference point = 1.00	Reference point = 2.00	Reference point = 3.00	Reference point = 4.00	Reference point = 5.00
Armed Attacks	9.65	9.24	8.863	8.48	8.126
	(6)	(4)	(4)	(3)	(2)
Arson	9.67	9.12	8.55	7.98	7.429
	(4)	(6)	(6)	(6)	(6)
Assassination	10.47	9.93	9.05	8.17	7.372
	(1)	(2)	(2)	(5)	(7)
Hostage	9.59	9.15	8.74	8.34	7.955
	(7)	(5)	(5)	(4)	(4)
Bombing	10.12	9.97	9.82	9.67	9.518
	(2)	(1)	(1)	(1)	(1)
Hijacking	9.66	9.25	8.869	8.49	8.124
	(5)	(3)	(3)	(2)	(3)
Kidnapping	9.96	7.97	6.29	4.72	3.192
	(3)	(8)	(8)	(8)	(8)
Unconventional	9.46	8.92	8.42	7.94	7.469
	(8)	(7)	(7)	(7)	(5)

Notes: The figures in the table are prospect values for each attack method category at each of five reference points. The figures in parentheses are the rankings, which are based on the prospect values, for each attack method category for each reference point. For example, at a reference point of 2.00, 'kidnapping' has a prospect value of 7.97, placing it in 8th (last) position in the preference ranking. The prospect values for Table 1 were computed under the assumption that outcomes are normally distributed. The prospect values have been scaled by a factor of 10 in order to make the interpretation easier. Like utility values, prospect values are ordinal and the absolute value and sign have no analytical meaning.

Table 2. Prospect values and preference rankings (log normal distribution)

Attack method category	Reference point = 1.00	Reference point = 2.00	Reference point = 3.00	Reference point = 4.00	Reference point = 5.00
Armed Attacks	10.02	10.01	10.01	10.006	10.004
	(6)	(5)	(4)	(3)	(2)
Arson	10.20	10.038	9.91	9.69	9.52
	(3)	(3)	(7)	(6)	(7)
Assassination	10.52	10.37	10.25	9.64	9.71
	(1)	(1)	(1)	(7)	(6)
Hostage	10.005	10.004	10.003	10.0014	10.0001
	(7)	(6)	(5)	(4)	(4)
Bombing	10.09	10.07	10.06	10.04	10.02
	(4)	(2)	(2)	(1)	(1)
Hijacking	10.04	10.032	10.02	10.01	10.0005
	(5)	(4)	(3)	(2)	(3)
Kidnapping	10.20	9.53	9.12	7.91	7.19
	(2)	(8)	(8)	(8)	(8)
Unconventional	10.004	10.003	10.002	10.0012	10.00
	(8)	(7)	(6)	(5)	(5)

Notes: The figures in the table are prospect values for each attack method category at each of five reference points. The figures in parentheses are the rankings, which are based on the prospect values, for each attack method category for each reference point. The prospect values for Table 2 were computed under the assumption that outcomes are log normally distributed. The prospect values in Table 2 have also been scaled by a factor of 10 in order to make the interpretation easier

Those lone wolf terrorists that have inflicted 2 or 3 injuries and fatalities have chosen less targeted attack methods, such as bombing and armed attacks or shootings. At the relatively low reference points of 2 and 3, however, the offender may still be observed to manage the variability of the outcomes by such means as directed parcel or letter bombings vis-à-vis leaving a bomb in a public place. Parcel bomber Roy Moody killed two people in separate bombing attacks, Rashid Baz killed one and injured two in an armed attack directed towards a group of Jewish students in New York City and Paul Hill, an anti-abortion activist, killed both a doctor and the doctor's companion in a shooting in Florida. It should also be noted that the letter-bomber, Theodore Kaczynski, killed three people in separate letter bombings over a period of two decades and injured many more in similar attacks. Although Kaczynski accumulated 26 injuries and fatalities, each of his attacks resulted in one or a small number of injuries or fatalities. The preference orderings that emerge from an application of prospect theory to the RAND-MIPT transnational terrorism data indicate that lone wolf terrorists with reference points of 1, 2 or 3 might place highly targeted assassination-type attacks and directed bombings atop their preference orderings. Furthermore, the analysis would lead us to expect that prospective lone wolf terrorists seeking to emulate the actions of these types of predecessors—exemplified by Moody, Baz, Hill and even Kaczynski—could be expected to choose assassination or directed bombing attacks just as their predecessors did.

In the United States, it has often been the case that armed attacks or shootings by lone offenders have resulted in 4, 5 or more injuries and fatalities. These include attacks perpetrated by Mir Aimal Kansi, Sirhan Sirhan, Buford Furrow, Richard Baumhammers, Hesham Mohamed Ali Hadayet and Naveed Afzal Haq. Some lone wolf terrorists have inflicted several fatalities in 'less targeted' bombings where bombs were left in public places rather than delivered to particular targets. Examples include Muharem Kurbegovich, who placed a bomb in a locker at Los Angeles Airport in August 1974 which killed 3 people and injured many others, and the Austrian terrorist Franz Fuchs, who killed 4 people when the bomb he had placed in a public park exploded. In most of the armed attacks or shootings the offender has selected a target location where he has opened fire on people in the vicinity. In some cases, such acts were followed by further violence. For example, Buford Furrow first opened fire at a community centre where he wounded five people. Later the same day at another location he murdered a postal worker. The preference orderings for reference points 4 and 5 show that, for the log-normal case, bombing and armed attacks gradually move towards the top of the preference

ranking and those attack methods with lower expected inflicted fatalities move further down the preference ranking as the reference point increases. Although some of the positions of the individual attack methods are in different positions when outcomes are assumed to be normally distributed, some of the same general characteristics are observed.

The reference points 1 to 5 encompass the outcomes of the actions of the majority of the lone wolf terrorists *for individual attacks*. Although a number of the 'serial' lone wolf terrorists inflicted more than five injuries and fatalities, they did so cumulatively with single attacks that did not usually inflict more than 1, 2 or 3 injuries and fatalities on any particular occasion. For example, each of the 3 fatalities inflicted by Theodore Kaczynski—the 'Unabomber'—were inflicted by 3 separate letter or parcel bomb attacks perpetrated months or years apart. Although Kaczynski inflicted a total of 26 injuries and fatalities, a prospective lone wolf terrorist seeking to emulate Kaczynski is more likely to have a reference point of 1 than a reference point of 26 and investigators would expect targeted assassination-type attacks from such an individual, a conclusion supported by our analysis that places 'assassination' atop the preference ordering for a reference point of a single injury or fatality. Unfortunately, the historical record of lone wolf terrorism also includes the actions of individuals who engaged in time-concentrated sprees of violence, usually shooting sprees, with much higher numbers of injuries and fatalities inflicted with a single attack.

The actions of Mark Essex, Colin Ferguson, Nidal Malik Hasan and Anders Behring Breivik exhibited this type of behaviour. This type of terrorism presents a particular challenge to law enforcement because of the amount of injury and fatality that might be inflicted within a very short period of time. Mark Essex injured and killed 23 people. Colin Ferguson injured and killed 25. Nidal Malik Hasan killed 13 and injured 42 others. Anders Behring Breivik killed 77 in a combined bombing and shooting attack. As the reference point increases two factors are observed: (1) attack methods with more variable or risky outcomes move higher in the preference ordering; and (2) the prospect value for each attack method declines because of the smaller probability of a gain—an outcome higher than the reference point. At higher reference points, every attack method has a relatively high likelihood of loss and only those attack methods with higher and more variable expected outcomes provide any reasonable prospect of producing an outcome in excess of the reference point. As such, bombing, armed attacks, unconventional attacks and hostage-taking move towards the top of the preference orderings. This

explains why those lone wolf terrorists seeking to emulate or exceed the outcomes of a particularly 'successful' predecessor may be observed to be relatively more risk-seeking. One of the features of prospect theory is its identification of 'risk seeking in the domain of losses' and 'risk aversion in the domain of gains'. For lone wolf terrorists seeking to emulate the outcomes achieved by an offender such as Essex, Franklin, Ferguson or Breivik, the domain of losses in the terrorism context is wide and the potential offender must be characterised by a willingness to seek risk across this wide domain of losses.

Past a certain reference point the order of the attack methods remains the same regardless of how much further the reference point increases. The chance of loss or an outcome below the reference point is very high. The prospect values that emerge when cumulative prospect theory is applied to these relatively high reference points places bombing and armed attacks at the top of the preference ordering followed by hijacking, hostage-taking and 'unconventional' attacks when outcomes are assumed to be normally distributed. When outcomes are assumed to be distributed log-normally, 'unconventional' attacks and hostage-taking emerge at the top of the preference ordering, followed by armed attacks, hijacking and bombing. For the normally distributed case, the two highest ranked alternatives are the alternatives that have been chosen by the predecessor lone wolf terrorists and we would expect a copycat lone wolf terrorist seeking to emulate the outcomes achieved by these offenders to also emulate the attack method chosen by their predecessor. When outcomes are assumed to be log-normally distributed, cumulative prospect theory implies that a potential lone wolf terrorist with a relatively high reference point will engage in the highest risk attack methods available. Rather than attempt to emulate both the outcomes and the method, the implication is that the copycat behaviour of the potential lone wolf terrorist may be asymmetric. Although the reference point is determined on the basis of the outcomes achieved by a particular predecessor, the method by which the potential lone wolf terrorist seeks to match or exceed those outcomes may be unique.

V. Conclusions

Copycat behaviour that might be exhibited by terrorists may be analysed using prospect theory once it is realised that the reference point may be the outcomes of terrorist actions perpetrated by a predecessor terrorist. Cumulative prospect theory enables the prospect values for alternative opportunities to be determined and for

those opportunities to be ranked in order of preference. We applied cumulative prospect theory to the lone wolf terrorist's choice from among alternative opportunities to inflict injuries and fatalities. We explored a context where a potential lone wolf terrorist engages in copycat behaviour with reference to a predecessor or reference point lone wolf terrorist and seeks to match or exceed the number of injuries and fatalities that were inflicted by that predecessor. The set of prospect values and preference orderings that were determined indicate that terrorists with lower reference points will choose more targeted attack methods or those with less variable outcomes. This would not only be consistent with copycat behaviour that seeks to emulate the outcomes of a predecessor but is also consistent with the method used by the predecessor.

At higher reference points the chance of loss is greater. Prospect theory differentiates between the 'domain of losses' and the 'domain of gains' and theorises risk-seeking behaviour in the domain of losses and risk averse behaviour in the domain of gains. Our analysis provides a contextual example of the practical implications of this type of decision-making behaviour. For terrorists with higher reference points the domain of losses is wide. It can only be bridged by taking more risk which in this case means choosing an attack method that is characterised by higher but more variable expected outcomes. This introduces the possibility that a potential lone wolf terrorist may choose an attack method that diverges from that used by his predecessor. If the predecessor or reference point lone wolf inflicted a number of injuries and fatalities that sits well above the number that could be expected to be associated with a repeat of the same type of attack, the potential terrorist may choose an attack method different from that of his predecessor.[14] The behavioural insights that can be obtained by analysing terrorist behaviour within a prospect theory framework go beyond those that can be obtained by the application of expected utility theory.

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[14] For example, a particular type of attack method may have a historical average number of inflicted injuries and fatalities of 5 and a standard deviation of 3. A particular attack may, however, inflict 19 injuries and fatalities. This may be due to particular circumstances that do not characterise attacks on average. As such, a potential lone wolf terrorist seeking to emulate the outcomes of this predecessor may choose an attack method that is expected to inflict a higher number of injuries and fatalities. Because a risk-reward trade-off characterises the terrorism context, this choice requires the potential terrorist to bear more risk.

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