Lone Wolf Terrorism: An Outcome of Emotive and Cognitive Economics

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Abstract

This paper uses game theory to model the lone wolf terrorist. Lone wolf terrorist is neither funded by a terrorist organization nor represents one. He/she undertakes a terrorist attack on his/her own capacity. It considers behavior of the lone wolf terrorist as the outcome of emotion and cognition. Emotions are represented through the social tie, whereas cognition is represented by loss aversion. In case of social tie, it is taken to be affecting the expected utility of the lone wolf terrorist. It can be positive or negative. Taking prospect theory into account, in the case of loss aversion, losses weigh twice the corresponding gains in terms of marginal gains and losses. The policy prescriptions in this case are to increase the level and intensity of punishment and the social ties.

Keywords

Lone Wolf Terrorist; Cognition; Emotion; Social tie; Counter-terrorism; Game Theory.

JEL Codes: C70, D04, D74, D90, D91, H10, H56.

1. Introduction

Terrorism is one of the gravest security threats that the world faces today. As per the Global Terrorism Index Report, 2023 released by the Institute of Economics and Peace, using the data from the Global Terrorism Database, 6,701 deaths were reported due to terrorism in the year 2022. The financial lossdue to terrorism in 2019 was US$26.4 billion. The indirect impacts of terrorism include costs on business and investment, insurance costs, lost opportunity, and the costs associated with security agencies in countering terrorism.

Groups like ISIL, ISKP, Boko Haram, Al Qaeda, Lashkar-e-Taeba, Tehrik-e-Taliban Pakistan, Al Shabaad, etc are some of the United Nations designated terrorist groups. The recent takeover of Afghanistan by the Taliban further aggravates the threat. To tackle this, the measures that the international community has been taking collectively include UNSC resolutions, BRICS declarations (New Delhi Declaration, Brasilia Declaration, etc), RATS under the SCO, etc.

As per the FBI[1], along with these groups, the threat of terrorism has evolved over time due to a variety of circumstances on both the domestic and international fronts. This evolution has made the problem of terrorism even more complex. These include-

(i)Lone wolfs - They frequently radicalise online and quickly mobilise to violence. It might be difficult to recognise, look into, and stop lone offenders since they lack a distinct group membership or leadership.

(ii)Internet and social media- Violent extremists from around the world including in the United States have established a significant internet presence through messaging services, online photos, videos, and publications. These help the groups recruit those who are open to receiving extremist messages and radicalise them. In an effort to facilitate home invasion attacks, social media has also given both local and foreign terrorists unparalleled virtual access to Americans.

This paper investigates the first element of the evolution of terrorism, that is, growing threat of attacks by lone wolf

[1] https://www.fbi.gov/investigate/terrorism

terrorists and provides policy prescriptions to address it. According to long-term data published by the Global Terrorism Index, 2019, the percentage of attacks carried out by individuals who had no affiliation with a terrorist organisation increased from less than 5% in the middle of the 1970s to more than 70% between 2014 and 2018. This clearly shows a rising threat from lone wolf terrorists, as highlighted by the FBI. Lone wolf carries out an attack independently of any official command or organisational structure. The lone wolf may or may not support a specific terrorist group and may not be driven by a wholly original philosophy or goal. Some examples of lone wolf terrorism are - Syed Rizwan Farook and Tashfeen Malik, a husband-and-wife team, assaulted a Christmas party hosted by Farook's job, the San Bernardino County Department of Public Health, in December 2015, killing 14. The bloodiest incident on American soil after 9/11 occurred in Orlando, Florida, in June 2016 when Omar Mateen massacred 49 people at a gay nightclub. Additionally, 86 people were killed in July when Mohamed Lahouaiej Bouhlel ploughed a vehicle through a Bastille Day gathering in Nice. It becomes difficult for the governments to identify and track such individuals. In such a scenario, the role of community to prevent a person from becoming a lone wolf terrorist, for example, by getting radicalised, becomes very important. Also, the probability of getting caught and severity of punishments play a role in deterring such attacks.

The paper studies the role of community in addressing the problem of lone wolf terrorism and the relative importance (in averting a person from becoming a lone wolf) of probability of getting caught or increasing the intensity of punishment. This is done by setting up an economic model that combines the cognitive and emotive aspects.

Rest of the paper is organized as follows. In the section 2, I have reviewed the literature. The section 3 is dedicated to the model and results. With section 4, I conclude and discuss the paper.

2. Literature Review

Terrorism is intended to achieve political goals by using or threatening to use violence, thereby creating fear in the minds of people and involving a much larger audience than those directly affected (Sandler and Siqueira 2009). A lone wolf terrorist carries out acts of terrorism in accordance with the definition, but they do so independently of any official command or

organisational structure. The lone wolf may or may not support a specific terrorist group and may not be driven by a wholly original philosophy or goal (Phillips 2011). The lone wolf issue is not new; throughout history, lone terrorists have carried out attacks without the organisational, operational, or direction of terrorist groups. However, it appears that this tendency has grown dramatically as a result of the increased usage of the internet (Hellmich 2008).

The preponderance of lone wolf attacks in recent years is also due, among other things, to the insurmountable obstacles terrorist groups confront when attempting to carry out organized assaults (attacks that are the result of initiative, planning, and participation by terrorist organizations). For instance, ISIS's loss of territory in Syria and Iraq, weakness of Al- Qaeda in various global theatres, and Hamas's operational constraints outside the Gaza Strip compelled these groups to ask independent lone actors to carry out attacks that were motivated by, or even carried out on behalf of, the aforementioned groups. Through propaganda and incitement spread online, these groups work to assist lone wolf attacks by enticing their followers around the world to carry out local assaults (Lakomy 2021). It has also been employed in diverse ways and to varying degrees of success by anti-abortion and separatist organizations (Byman 2017).

Considering the growing threat of lone wolf attacks, it becomes imperative to look at the measures to avert it. When compared to the body of research on global, group-based terrorism, the literature on local, lone-wolf terrorism is thin.[2]

A lone wolf terrorist can be conceptualized as someone who is trying to maximise an expected utility function like the expected utility functions for criminal behaviour developed by Becker (1968) or Ehrlich (1973), which were adapted by Landes (1978) for the analysis of hijacking. The lone wolf makes security organisations and analysts' jobs more difficult. Lone wolves independently organise their actions and this may produce a succession of "point attacks" marked by "once-off" specific attack types against specific targets. Security organisations can use the deterrent effect on a lone wolf by properly predicting the target or nature of the assault (or by enforcing tougher penalties). Higher security and heavier sanctions may be expected to dissuade lone wolves from attacking a certain target or category of target and force them to switch their tactics (Phillips 2011).

[2] Mark Hamm, "Lone-Wolf Terrorism in America: Forging a New Way of Looking at an Old Problem," Indiana State University, May 2013, 3, http://informationcollective.org/lone-wolf/.

Phillips (2011) looks at how applying economic analysis can reveal new information about the characteristics of lone wolf terrorism. In order to fully explore the implications of the theory on lone wolf terrorists, Phillips (2011) made seven predictions from the mean-variance theoretical framework and produced numerical estimates as a first step. Most crucially, lone wolves are predicted to use unorthodox techniques like hostage kidnapping, bombing, assassination, or armed attack depending on their level of risk aversion (or desire).

Phillips (2013) assumes that every attack strategy that a lone wolf terrorist might select has an estimated payoff (mean or average) and risk (standard deviation or variance). The lone wolf terrorist may have to weigh reward versus risk while making decisions. He/ she will select riskier attack strategies with bigger anticipated rewards if he is less risk-averse. He/ she will select less hazardous assault strategies with lower projected rewards if he is more risk averse. Therefore, the ranking of choices of attack by the lone wolf terrorist is done after the analysis of the risk-reward ratio. Using RAND-MIPT data base, Phillips (2013) finds that the mean predicted injuries and fatalities and the standard deviation of actual results from expected outcomes make up the preference ordering that the lone wolf terrorist uses to make his decisions.

The pioneering paper by Becker (1968) establishes that criminals are not irrational. They maximise their expected utility before choosing to carry out any kind of attack. But despite taking this into account and providing adequate incentives, the school that advocates for rational terrorist actually end up prescribing inaccurate solutions to a plethora of criminal activities (Garoupa 2003). This provides for an immense potential for behavioural economics to fill this lacuna. Garoupa (2003), McAdams and Ulen, T. (2008), Jolls (2005) etc are some papers in this direction. A lone wolf terrorist is also a criminal and it is important to incorporate the aspect of behavioural economics its analysis.

Winden and Ash (2012) investigate the impact of brain science's mechanistic on the economics of crime. The paper is based on the idea that humans are "ecologically rational," that is, decision making is a by-product of evolutionary adaptations. So, in this way, it incorporates the behavioural economics to investigate the economics of crime by classifying a human being to have decision making ability based on cognition and emotions. Cognition is conceptualised as information processing by the brain for decision making (Geary 2005). It is developed through evolution and can be said to approximately denote

rationality. For example, memory, reasoning, problem-solving etc. Whereas, emotions are present in human beings by default. These can be referred to as specialised brain modules to solve problems (Tooby and Cosmides 1990). Emotions and cognitions are taken as quasi-independent, that is, they differ in speed but act on the same stimuli. Emotions produce prewired and swift responses, while cognition produces a slow response as it is taken after doing proper cost-benefit analysis in the mind depending upon past experiences (LeDoux 1998). Economic theory generally takes cognition and ignores emotions; however, this paper incorporates both.

Therefore, using the unique characteristics of the lone wolf attacker and incorporating cognition and emotions can provide a unique way to find out the policy prescriptions for the government to reduce the likelihood of the lone wolf terrorist attacks.

Cognition can lead to several effects on decision making, but Winden and Ash (2012) focus on three of the impacts, namely, risk attitudes, loss aversion and, time preferences. Risk assessment by criminals involves a probability that their attack may be unsuccessful and hence, they finally make their decision based on the net pay off that they can get by considering the uncertainty. Alm et al. (2009) recommend that the quantum of punishment should be very clear to reduce criminal activity. For instance, in the case of tax evasion, if the probability of audit is very clear, then, the cases of tax evasion are lowest.

Prospect theory, which has an abundance of experimental data to back it up, demonstrates that people's attitudes about risk consistently deviate from expected utility theory. Humans exaggerate the difference between zero probability and small probabilities, while small values are overstated and high probabilities are underestimated, according to experimental observation of probabilistic decision making. People determine whether an economic change is a gain or a loss both prospectively and retrospectively by valuing outcomes in comparison to some reference point, and they react systematically differently to gains and losses. (Tversky and Kahneman 1992). Loss aversion is modelled using the prospect theory. Because it suggests that punishment (seen as a loss) will have a stronger deterrent effect than what the rational crime model predicts, loss aversion is crucial for the management of crime. The behavioural model of crime also makes use of loss aversion since illicit appropriations may result in net welfare losses even if they involve the transfer of goods. According to this theory, endowment effects, that is known as loss-aversive

attitudes toward property cause victims and criminals to place a higher value on owned than on non-possession items (Huck et al 2005).

Time preferences are modelled in a way such that greater preference is given for immediate gain vis a vis future gain, that is, future gains are discounted hyperbolically[3]. This leads to impulsive crime (there is extra incentive to commit the crime in the young period).

Apart from cognition, economic conduct is significantly influenced by emotions (Elster (1998); Loewenstein (2000); Rick and Loewenstein (2008); van Winden (2007). Different emotions that can play a significant role in modelling the lone wolf terrorist's expected utility function are anger, revenge, empathy, sympathy, guilt and social tie. Anger is a negative hedonic value emotion that is brought on by the perception of unfulfilled desires. Retaliation is, to put it simply, the action propensity of anger. Even if the act of reciprocating injury is (perhaps) costly, anger encourages those who are provoked to do so. Altruistic punishment is the term used to describe this expensive negative reciprocation phenomena (Fehr and Gächter 2002). Anger is unforeseeable and hence, it is difficult to balance the marginal cost and benefit. Also, some criminal activities are so complex and isolated that they do not generate angry retaliation. But law enforcement can come to rescue in this case. Anger from the perspective of behavioural economics can be seen as an emotion that can either be directed towards an individual or the government. It can be modelled in the form of an ultimatum game, in short, the power to take game (Bosman et al 2005).

Shame and guilt are "self-reproach" which generate a kind of discomfort by disobeying rules (Ortony et al 1988). The greater the violation, the greater will be the discomfort and more will be the crime deterrence. So, humans abide by social norms to avoid shame and guilt. Coricelli et al. (2007) through empirical study find that publicising the photographs of tax evaders induce shame and hence reduce the instances of tax evasion.

Thirdly, empathy, sympathy, and social ties form important components of emotion. Empathy helps in cooperation and helping others. Sympathy can be inferred to as the positive

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[3] In traditional exponential discounting, the weights on the different periods are 1, δ, δ^2etc, where $0< \delta <1$.

For hyperbolic discounting the weights are 1, $\beta * \delta$, $\beta * \delta^2$, $\beta * \delta^3$ etc, where $0<\beta<1$ and $0< \delta <1$.

counterpart of anger. Sympathy and empathy discourage criminal behaviour. Psychopathic personalities are mostly incapable to feel empathetic (Blair et al 1997). Although many people might be impacted by crime, these victims are typically those with whom the offender has tenuous social links. For individuals with whom the criminal retains positive social relationships, this model predicts a preference for crimes that provide positive externalities and avoid negative externalities, and vice versa for those with whom the criminal maintains negative social ties. In addition to being logical and intuitive, the social ties hypothesis is congruent with the results of various tests (Reuben and Van Winden 2008).

Four factors are used in the formulation of a broad model of lone wolf terrorism for the investigation's purposes: the degree of radicalization, motive, form, and risk awareness. Lone wolf terrorism is modelled after the Rubik's Cube in these four dimensions (Bates 2012). The social tie can be included while talking about the second factor, that is, motivation. In some cases, egotistical or self-centered lone wolf terrorists may believe they are above the limitations of society and a particular ideological group. They may be aware of radical publications, literature, or websites, but they exhibit severe antisocial traits (Timascheff 1966). Both Timothy McVeigh, the Oklahoma City bomber, and Ted Kazinsky, the Unabomber, were social outcasts who felt either singularly "called" or uniquely capable of committing and executing crimes due of their sense of self-superiority (Bates 2011). Altruistic lone wolf terrorists, however, are more driven by a sense of duty to a cause or mission. Both Nidal Hassan (at Fort Hood) and Faisal Shahzad (in Times Square) defended their deeds as acts of selflessness that showed their dedication to a bigger purpose.

Taking the above literature as the foundation, this paper has modelled the lone wolf terrorist action as a factor of both cognition and emotion. This is a new contribution to the literature of the lone wolf terrorists. Emotions are represented through the social tie, whereas cognition is represented by loss aversion. In case of social tie, it is taken to be affecting the expected utility of the lone wolf terrorist. It can be positive or negative. It will be positive if the social ties are strong (Levy and Peart 2009). For example, this happens in the case of kinship group/ community. Here, the lone wolf terrorist derives a positive utility from overall increase in the utility of the community. It will be negative if the terrorist utility increases with a decrease in the utility of the society when he/she is driven by emotions like high levels of anger, hatred and sense of

revenge (Taylor and Taylor 2009). Prospect theory's assertion that "losses loom greater than matching gains" is supported by experimental data (Tversky and Kahneman1991). Therefore, in the case of loss aversion, losses weigh twice the corresponding gains in terms of marginal gains and losses (Winden and Ash 2012). Therefore, the lone wolf's likelihood of attack is taken as dependent on the social tie and loss aversion. The thesis finds out the importance of social tie in averting a person to become a lone wolf attacker. It also goes on to find the relative importance of increasing the likelihood of getting caught and the severity of punishment on reducing the probability of the lone wolf's attack. Therefore, it provides a policy prescription for the government's counter-terrorist measures.

3. Model

The level of terrorist attack is taken as x, where $x \epsilon [0, 1]$. p is taken as the probability of getting caught (by increasing security, intelligence, better international cooperation, increased vigilance by the private players, etc). If the terrorist is caught, he/she is punished and the degree of punishment varies with the degree of terrorist attack. Punishment on getting caught is represented by f. This includes jail, death penalty, boycott of the terrorist's family from the society, etc. $f \epsilon [0, 1]$. Punishment also depends on the intensity of the terrorist attack and the social tie/ role of the community. This can be represented as f = f (x, a), where a is taken as the social tie. y represents the level of government regulations. y is a function of probability of being caught and punishment when he/she is caught, that is, y = y (p, f). Also, j represents the other members of the society/ community. EU_j is the expected utility of the other members of the society. $EU_j = g(x)$, that is, EU_j is a function of the level of terrorist attack. aEU_j (x) represents the effect of social tie and the level of expected utility of rest of the members of the community on the expected utility of the lone wolf terrorist.

Let G be the benefit that lone wolf terrorist gets from carrying out the attack.

G = V (x, y, f (x, a))

$\frac{\delta EUj}{\delta x} < 0$, as terrorist attack increases, the society becomes a less conducive place to live.

$\frac{\delta f}{\delta x} > 0$, as the level of terrorist attack increases, punishment increases.

$\frac{\delta V}{\delta x} > 0$, the benefit to the lone wolf attacker increases with an increase in level of attack.

$\frac{\delta V}{\delta f} < 0$, the benefit to the lone wolf attacker decreases with an increase in the level of punishment if caught.

Assuming, the terrorist has loss aversion, punishment is taken as the loss. Due to the endowment effect, a greater value is attached to possessed goods than non- possessed ones.

Let L denote the loss to the lone wolf attacker. Loss provides twice the disutility than the utility from the attack. Therefore, L = -2G.

Therefore, the expected utility of the lone wolf attacker from the attack is

$EU=(1-p)G+pL+aEU_j(x)$ 1.

$\Rightarrow EU = (1-p)\ G + p\ (-2G) + a\ EU_j\ (x)$

$\Rightarrow EU = G - pG - 2pG + a\ EU_j\ (x)$

$\Rightarrow EU = G - 3pG + a\ EU_j\ (x)$

$\Rightarrow EU = (1-3p)\ G + a\ EU_j\ (x)$

$\Rightarrow EU= (1-3\ p)G+aEU_j(x)$ 2.

Using $G = V\ (x, y, f\ (x, a))$ in 2

$\Rightarrow EU=(1-3p)[V(x,y,f(x,a)]+aEU_j(x)$ 3.

3.1 Effect of increase in the level of terrorist attack on the expected utility of the lone wolf terrorist

Proposition 1 – The likelihood of attack decreases when social cohesion is high. This happens in both the cases of the punishment effect outweighing the direct effect and vice versa.

Proposition 2- Deterrence effect is represented in two cases-

(i) Even with low probability of getting caught, the likelihood of attack decreases when the disutility from the punishment effect is high and social tie is positive.

(ii) Even when the probability of getting caught is low and the sense of anger and revenge is high, the likelihood of attack decreases with a high punishment effect.

Proof-

$$\frac{\delta EU}{\delta x} = (1\text{-}3p)\left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right] + a\frac{\delta EUj}{\delta x}$$

Case 1 – When punishment effect is greater than the direct effect

$$\left|\frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right| > \left|\frac{\delta V}{\delta x}\right|$$

Case 1.1 When a is positive

Case 1.1.1 When probability of getting caught is less than 0.333, that is $p < 0.333$

$$\Rightarrow \frac{\delta EU}{\delta x} < 0$$

Therefore, even if the probability of getting caught is low, the likelihood of attack decreases if the punishment is stringent. If there is marginal increase in the severity of the attack and the government responds by a large increase in the level of punishment awarded, then this represents deterrence effect.

Case 1.1.2 When probability of getting caught is more than 0.333, that is $p > 0.333$, then there are two cases.

Case 1.1.2.1 When $a\frac{\delta EUj}{\delta x} > (1\text{-}3p)\left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right]$, that is, the disutility from the terrorist attack to the society is very high and as social tie is positive, this disutility to the society has a greater impact than the terrorist's own net effect from the attack. There is high level of social cohesion in the community.

$$\Rightarrow \frac{\delta EU}{\delta x} < 0$$

Therefore, in this case, the likelihood of attack decreases.

Case 1.1.2.2 When $a\frac{\delta EUj}{\delta x} < (1\text{-}3p)\left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right]$, that is, the lone wolf terrorist is less attached to the society.

$$\Rightarrow \frac{\delta EU}{\delta x} > 0$$

Therefore, in this case, the likelihood of attack increases.

Case 1.2 When a is negative

Case 1.2.1 When probability of getting caught is less than 0.333, that is $p < 0.333$, then there are two cases.

Case 1.2.2.1 When a $\frac{\delta EUj}{\delta x} > (1\text{-}3p) \left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f} \frac{\delta f}{\delta x} \right]$, that is, where the lone wolf terrorist's anger and sense of revenge outweighs the disutility that he/ she gets from the punishment effect.

$$\Rightarrow \frac{\delta EU}{\delta x} > 0$$

Therefore, the lone wolf attacker is going to be better off if he/ she carries out high a high intensity attack.

Case 1.2.2.2 When a $\frac{\delta EUj}{\delta x} < (1\text{-}3p) \left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f} \frac{\delta f}{\delta x} \right]$, where the lone wolf terrorist's anger and sense of revenge is outweighed by the disutility that he/ she gets from the punishment effect.

$$\Rightarrow \frac{\delta EU}{\delta x} < 0$$

Therefore, even if the probability of getting caught is low, when the lone wolf attacker has high level of anger and sense of revenge, it is outweighed when the punishment effect is very strong. This also represents the deterrence effect.

Case 1.2.2 When probability of getting caught is more than 0.333, that is $p > 0.333$, then

$$\Rightarrow \frac{\delta EU}{\delta x} > 0$$

Therefore, even if the probability of getting caught is high for the lone wolf terrorist, the level of anger and sense of revenge are so high that the likelihood of attack increases.

Case 2 – When direct effect is greater than the punishment effect

$$\left| \frac{\delta V}{\delta f} \frac{\delta f}{\delta x} \right| < \left| \frac{\delta V}{\delta x} \right|$$

<u>Case 2.1 When a is positive</u>

Case 2.1.1 When probability of getting caught is less than 0.333, that is $p < 0.333$, then there are two cases

Case 2.1.1.1 When a $\left| \frac{\delta EUj}{\delta x} \right| > (1\text{-}3p) \left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f} \frac{\delta f}{\delta x} \right]$,

$$\Rightarrow \frac{\delta EU}{\delta x} < 0$$

This is the case of high social cohesion. Even if the probability of being caught is low and the direct effect from the attack outweighs

the punishment effect, due to high level of social ties, the likelihood of attack decreases. For example, in countries like India. Terrorist groups like the ISIS could not hold a strong support due to high level of social unity and brotherhood.

Case 2.1.1.2 When a $\left|\frac{\delta EUj}{\delta x}\right| < (1\text{-}3p)\left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right]$,

$\Rightarrow \frac{\delta EU}{\delta x} > 0$

Therefore, low level of social ties combined with low probability of getting caught and high direct effect lead to increased likelihood of attack.

Case 2.1.2 When probability of getting caught is greater than 0.333, that is $p > 0.333$

$\Rightarrow \frac{\delta EU}{\delta x} < 0$

Therefore, even if the direct effect is strong, the probability of getting caught if high enough to reduce the likelihood of the attack.

Case 2.2 When a is negative

Case 2.1.1 When probability of getting caught is less than 0.333, that is $p < 0.333$

$\Rightarrow \frac{\delta EU}{\delta x} > 0$

The likelihood of attack increase. This is obvious because of the combined effect of a low probability of getting caught, anger and sense of revenge and the fact that direct effect outweighs the punishment effect.

Case 2.1.2 When the probability of getting caught is more than 0.333, that is $p > 0.333$, then there are two cases.

Case 2.1.2.1 When a $\frac{\delta EUj}{\delta x} > (1\text{-}3p)\left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right]$,

$\Rightarrow a\left|\frac{\delta EUj}{\delta x}\right| < (1\text{-}3p)\left|\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f}\frac{\delta f}{\delta x}\right|$,

$\Rightarrow \frac{\delta EU}{\delta x} > 0$

Therefore, even if the likelihood of getting caught is high, the likelihood of attack increases because of high level of anger in the lone wolf attacker and the fact that the direct effect outweighs the punishment effect.

Case 2.1.2.2 When a $\frac{\delta EUj}{\delta x} < (1\text{-}3p) \left[\frac{\delta V}{\delta x} + \frac{\delta V}{\delta f} \frac{\delta f}{\delta x} \right]$,

$\Rightarrow a \left| \frac{\delta EUj}{\delta x} \right| > (1\text{-}3p) \left| \frac{\delta V}{\delta x} + \frac{\delta V}{\delta f} \frac{\delta f}{\delta x} \right|$,

$\Rightarrow \frac{\delta EU}{\delta x} < 0$

The likelihood of attack decreases when the probability of getting caught is high such that it outweighs anger and the direct effect.

The above proof points to the fact that high marginal punishment is more effective in deterring a lone wolf terrorist to attack even with a low probability of getting caught. Hence, the government can divert the limited resources used for increasing the probability of getting caught to other uses like infrastructure, education, etc and still deter the terrorist attack by committing to high level of punishment, if caught.

QED

3.2 Effect of increase in the likelihood of getting caught on the expected utility of the lone wolf terrorist

Proposition 3- The likelihood of attack decreases with the increase in the probability of getting caught.

Proof –

$\frac{\delta EU}{\delta p} = -3 [V (x, y, f (x, a)] < 0$

$\frac{\delta EU}{\delta p} < 0$

QED

3.3 *Effect of increase in the punishment on the expected utility of the lone wolf terrorist*

Proposition 4.1 – If the probability of getting caught is low, the deterrence effect works, that is, as the level of intensity of punishment increases, likelihood of attack decreases.

Proposition 4.2- If the probability of getting caught is high, even with an increase in punishment, the likelihood of attack increases.

Proof –

$\frac{\delta EU}{\delta f} = (1\text{-}3p) \frac{\delta V}{\delta f}$

There are two cases,

Case 1.1.3.1 When probability of getting caught is less than 0.333, that is $p < 0.333$

$$\frac{\delta EU}{\delta f} < 0$$

Case 1.1.3.2 When probability of getting caught is more than 0.333, that is $p > 0.333$

$$\frac{\delta EU}{\delta f} > 0$$

Therefore, if the probability of getting caught is high, even with an increase in punishment, the likelihood of attack increases. This is because getting caught and punished will increase the media coverage, which according to the lone wolf terrorist will make people aware about his dedication towards the cause and hence, reduce instances that he opposed. For example, the case of xenophobia, racism, etc.

QED

4. Discussion

The policy prescription from the paper is that given the limited resources with the government, the likelihood of the attack by the lone wolf terrorist can be decreased by making the punishment more stringent than by increasing the probability of getting caught by increasing security measures and intelligence. This comes from the deterrence effect. Also, the government should try to increase the social cohesion through campaigns like Ek Bharat Shrestha Bharat by the Government of India. This is because in the communities that have high level of social ties, the likelihood of attack by a lone wolf terrorist decrease.

This paper is an addition to the literature on the economic theory of lone wolf terrorists. It has contributed by combining the effects of cognition and emotions through loss aversion and social tie respectively on the likelihood of attack by the lone wolf terrorist. Also, an interesting result is that sometimes increasing the probability of being caught beyond a point is counter-productive in terms of weakening deterrence (Proposition 2). This model can be extended further to explore the effects of intertemporal preferences, empathy, and guilt on the likelihood of attack by the lone wolf terrorist.

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Appendix -Tradeoff between increasing the level of punishment (f) and probability of getting caught (p) for the government by checking the elasticities

Proposition A.1 – Even when probability of getting caught is low, the likelihood of attack decreases more with the increase in level of punishment than the probability of getting caught, when $-3vp < (1-3p)f\ \frac{\delta V}{\delta f}$.

Proposition A.2 – When probability of getting caught is high, increasing the level of punishment is more effective in reducing the likelihood of attack than further increasing the probability of being caught.

This is in line with the policy prescription of the chapter.

Proof –

Elasticity of the expected utility of the lone wolf terrorist with respect to the probability of being caught (p)-

$$e_p=\frac{\delta EU}{\delta p}\frac{p}{EU}=\frac{-3vp}{(1-3p)v+a\,EUj(x)} \qquad \text{A.1.}$$

Elasticity of the expected utility of the lone wolf terrorist with respect to the level of punishment (f)-

$$e_f=\frac{\delta EU}{\delta f}\frac{f}{EU}=\frac{(1-3p)f\frac{\delta V}{\delta f}}{(1-3p)v+a\,EUj(x)} \qquad \text{A.2.}$$

To check the trade off, comparing 4 and 5, and assuming the denominator, that is, $(1-3p)v+a\,EUj(x)$ to be positive. This is assumed to be positive because this model restricts itself to the case

where the increase in probability of getting caught actually affects the lone wolf terrorist negatively.

Case 1 - When probability of getting caught is less than 0.333, there are two cases-

Case 1.1- $-3\mathrm{vp} > (1-3\mathrm{p})f\ \frac{\delta \mathrm{V}}{\delta \mathrm{f}}$

The responsiveness of the expected utility of the lone wolf attacker to the probability of being caught is more than that of the level of punishment, even when probability of getting caught is low. This is the case when the benefit from the attack is very high.

Case 1.2- $-3\mathrm{vp} < (1-3\mathrm{p})f\ \frac{\delta \mathrm{V}}{\delta \mathrm{f}}$

The responsiveness of the expected utility of the lone wolf attacker to the level of punishment is more than the probability of being caught, when probability of getting caught is low. This is the case when the disutility from the attack is very high, that is, high $f\ and\ \frac{\delta \mathrm{V}}{\delta \mathrm{f}}$.

Case 2- When probability of getting caught is more than 0.333

$-3\mathrm{vp} < (1-3\mathrm{p})f\ \frac{\delta \mathrm{V}}{\delta \mathrm{f}}$

Therefore, when the probability of getting caught is high, the responsiveness of the expected utility of the lone wolf terrorist to the level of punishment is high as compared to the probability of getting caught.

QED