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Abstract

This paper uses game theory to study whether the counter-terrorism efforts of the government and anti-terrorism precautions taken by private players are substitutes or complements. It investigates the case of multiple equilibria. The analysis suggests that the government spend on creating awareness amongst the citizens about being vigilant.

Keywords

Counter-terrorism; Game Theory; Government; Private players; Vigilance; Complements; Substitutes.

JEL Codes: C70, D74, H10, H56.

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1. Introduction

Terrorism is one of the gravest security threats that the world faces today. Groups like ISIL, ISKP, Boko Haram, Al Qaeda, Lashkar-e-Taeba, Tehrik-e-Taliban Pakistan, Haqqani network, 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 Global Terrorism Index Report, 2020 released by the Institute of Economics and Peace, using the data from theGlobal Terrorism Database, 13,826 deaths were reported due to terrorism in 2019. 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. Along with this there is heightened fear created in the minds of people.

There is no universal definition of terrorism, yet. As per the US FBI, terrorism is the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives. The economic literature on terrorism defines it as an act 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.

The counter-terrorism measures include increasing security (door frame metal detectors, hand held metal detectors, scanning machines at places like metros stations, airports, railway stations, and public places), prompt intelligence, international cooperation, alert and vigilant citizens, de- radicalisation, preventing alienation, better

employment opportunities, etc.

The private players (citizens) in a country play an integral role in the strategy to combat terrorism. The private players put in efforts in terms of being vigilant, which is costly for them, to address the problem of terrorism. Governments across the world have noted this and often issue advisories tothe citizens to be vigilant in their daily lives. As citizens, we often come across advisories issued by the government to be vigilant while traveling in public transport, monitoring neighbours, andreporting any suspicious activities. Therefore, it is interesting to investigate the relation between thegovernment's and private player's anti-terrorism efforts from the policy perspective. The pioneering paper on the economics of illegal activities by Becker (1968) suggests that private players play a significant role as far as countering the criminal activities are concerned. Government and private players may be able to work together to create deterrence effect. At thesame time, efforts by private players reduce the burden of the government in ensuring national security.

This paper sets up a model involving a simultaneous game, where the counter-terrorist measures of both private players and the government are functions of each other. I investigate the relationship between the anti-terror efforts of government and private players, from the government's as well as from the private players' perspective. Rest of the paper is organised 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 the paper.

2. Literature Review

Efforts of private individuals in terms of taking precautions are as important as the government's measures to address crime. Since the state's resources are limited and the threat of terrorist attack is real, optimal allocation of these resources is required. For this, it is essential to check therelationship between government and private efforts to

counter the attack.

Becker (1968) is the pioneering paper that viewed crime from the lens of economics. It takes the government's measures to address crime and private prevention efforts as substitutes. This is in line with the Peltzman Effect[1]. Peltzman (1975) states that greater safety regulations undertaken by the government may prompt adverse and reckless behavior on the part of private individuals due to moral hazard. This in turn offsets the initial measures taken by the government.

Shavell (1991) studies the effect of private players' precautions (acting individually and collectively) on the number of thefts. It divides precautions into observable precautions (installing iron rods on windows) and unobservable precautions (putting in a safe to store valuables). When a private player acts individually and installs iron rods, it leads to two effects. First, there is a diversion effect - the thief, on seeing the rods, decides to steal from another house so that the theft isdiverted. Secondly, there is a theft reduction effect - it may be difficult and time-consuming for the thief to view the items to be stolen clearly through the rods, thereby leading to a decrease in the expected value of the stolen amount. If the individual instead chooses to put in a safe to store valuables, then (assuming that thieves are unaware that the house has a safe) this will only have a theft reduction effect and not a diversion effect (the thief anyways decide to steal from his house, but finds it difficult to do so because of the safe). On the other hand, if individuals act collectively, there will be two effects - a theft reduction effect and a deterrence effect (if all the houses have safety measures installed, the thief will have a tough time stealing, thereby reducing the marginal propensity to steal and may even not steal at all). So, in the case of installing observables, individuals put in more precautions than the socially desirable level (as they do not internalize the diversion effect).

1.Peltzman effect is in context of regulation that drivers must use seat belts. The aim is to reduce fatalities caused by road accidents. But this may lead to moral hazard, wherein the drivers end up driving more recklessly.

However, for unobservable precautions, individuals put in less than the socially desirable level, believing that others have already taken the precautions and that this will lead to a deterrence effect (free-riding).

Hylton (1996) demonstrates that private player precautions are less than socially optimal due to three reasons. First, precautions taken by one individual may lead to the diversion of crime to another. In totality, this leads to too much or too little precautions (Shavell, 1991). Secondly, peopletend to free-ride on the precautions of others when these precautions are partially observable. Third,they are neither compensated for injury nor do they bear the enforcement cost here. In such a scenario, if the government precautions are visible, the private players over-rely on them.

States monopolize law enforcement. This is because of three reasons. The first is due to the public good character of policing. Moreover, one policeman is better than hiring private guards for every house in a locality. It effectively helps in cost-cutting (Konrad and Skaperdas, 2012). Secondly, thisprevents negative externalities (the private guard may help in diverting crime to other houses) (Clotfelter, 1978). Third, the state can commit to a certain level of precautions (Grechening and Kolmar, 2011). Grechening and Kolmar (2011) observe that private efforts to counter crime may betreated as substitutes by the government (moral hazard on the government's part), thereby reducing the state's enforcement.

Guha and Guha (2012) investigate the question of whether an increase in policing by the government by increasing expenditure on crime prevention necessarily leads to a reduction in private precautions due to moral hazard. The various types of precautions that they consider are – (1) those that directly foil the attack (buying a gun); (2)

diversifying assets (costly diversification) such that the criminal finds it costly to attack (for example, he might only be able to steal a small amount, as people store most of their valuables in banks); (3) a combination of both the above methods. The paper finds that it is not necessarily the case that government measures always reduce private efforts. There are conditions when the two are complements.

Many empirical studies have examined the effect of policing on crime and find a negative relationship. These include Levitt (1997)'s study on elections, policing, and crime, Marvell and Moody (1996), and Eck and Maguire (2000). Lin (2009) controlling for endogeneity, has used statesales tax as an instrumental variable and found the same result.

This paper aims to study the relationship (substitutability or complementarity) between government's anti-terrorism measures and private player's effort in being vigilant. The government should take into consideration the private precautions taken against terrorist attacks while formulating its policies against the terrorist groups.

3. Model

There are two players - government and private players, who face a certain probability of terrorist attack. The terrorist group's probability of attack is exogenous. The government spends a part of its budget on anti-terrorist activities. Let 'α' be the measure of the anti-terrorism cost to the government.

At the same time, the private players also contribute towards foiling terrorist attacks by being vigilant. In doing so, the private players need to put in effort 'e', which is costly.

Government and private players move simultaneously choosing 'α' and 'e' respectively, given an exogenous probability 'p' of an attack by a terrorist group. The solution concept of the paper is to find out the Nash equilibrium.

This model tries to investigate whether the government's and the private players' anti-terrorist measures are complementary or whether they function as substitutes.

The following variables are used-

α - Probability that the government is spending the resources on anti-terrorist measures, where $\alpha \varepsilon [0,1]$.

$\alpha = H(e)$, where 'e' is the effort put in by the private players in being vigilant. So, the expenditure on anti-terrorist activities by the government is a function of the effort level put in by the private players. At this point, no assumptions are made about the sign of H'(e).

So, 'α' is a measure of the cost to the government. Other symbols are as follows.

p - Probability that the attack by the terrorist group actually takes place.

e - Effort put in by the private players in being vigilant. $e \varepsilon [0,1]$.

W - Wealth that the private players have, in terms of money, property, health etc.

$e^2/2$ - Private players' cost of putting in effort.

F - Loss to the private players if there is a successful attack by the terrorist group. In that case, thetotal leftover wealth with them will be 'W-F'. If the attack is unsuccessful, the private players will end up with 'W'.

The effort of the private players is a function of 'α'.

Assumptions-

(i). If either of the private players or the government puts in effort or spends on counter terroristmeasures respectively, the attack by the terrorist group will be unsuccessful.

(ii). The private players are risk neutral.

The following represents the payoff tables. The payoffs of the government and the private playersare specified in the tables-

(i). The terrorist group attacks - Probability “p”

Private Player

Government 's expenditure on	Vigilant	Not Vigilant
Anti terror	a - H(e), $W-e^2/2$	b-H(e), W
Not on Anti terror	c-E, $W-e^2/2$	-M, W-F

(ii). The terrorist group does not attack - Probability “1-p”

Private Player

Government 's expenditure on	Vigilant	Not Vigilant
Anti terror	-H(e), $W-e^2/2$	-H(e), W
Not on Anti terror	0, $W-e^2/2$	0, W

Explaining the payoffs-

(i). a > b - This represents the fact that if the government and the private players both put in efforts to foil the terrorist attack, then this sends out a message that the country is united in the fight against terrorism. If there is a united fight, then this acts as a strong deterrence to the terrorist group, thereby creating a deterrence effect. In such a scenario, the government gets a higher payoff than in the case when the terrorist attack is averted only due togovernment's anti-terrorist measures.

(ii). a, b > c - Government gets different payoffs when the terrorist attack has been successfully averted, depending upon whose efforts have actually resulted in this. The payoffs aremaximum when both the private players and the government put in the effort ('a'). Payoffs are intermediate in the case when the attack has been foiled only due to government's effort ('b'). The payoffs are least in the case when the attack has been successfully averted only due to private players efforts ('c'). This is due to the fact that the citizens are segregated andso are their efforts. There is definitely a need for a central agency to coordinate these efforts in order to be more effective in sending out a strong message to the terrorist group and the government plays this role.

(iii). E - Cost to the government in terms of loss in reputation because the attack has been foiled only due to private players efforts and the government failed to take any anti-terrorist measures.

(iv). -M < -E - This is due to the fact that the loss is higher when the attack actually happens ('- M').

Proposition 1 *- From the government's point of view, the probability of anti-terrorist expenditure by government is -*

1(a)- complementary to the anti-terrorist efforts by the private players, when a-b-c > M-E.1(b)- substitutable to the anti-terrorist efforts by the private players, when a-b-c < M-E.

Proof - See Appendix 1.

Intuitively: a-b-c > M-E can be written as a-b > (c-E) + M. The left-hand side represents the benefit to the government from private players' vigilance when the government also spends on anti-terrorist measures. Whereas, the right-hand side represents the benefit to the government from privateplayers' efforts when the government is not spending on anti-terrorist measures. Since the benefit tothe government from private players' effort when the government spends on counter terroristmeasures is more than when it does not spend on it, so, it can be concluded that the government's and private players' efforts are complementary. This is more likely to be the case if (i) the "united front" has a strong deterrence effect on terrorism, so that a-b is high, (ii) if c is relatively low, so that private players' efforts, being segregated, are not too effective on their own.

Similarly, a-b-c < M-E can be written as a-b < (c-E) + M. Since the benefit to the government from private players' effort when the government spends on counter terrorist measures is less than whenit does not spend on it, so, it can be concluded that the government's and private players' efforts aresubstitutes. This is more likely to be the case when private players acting on their own are relativelyeffective (high c), when E is low (there is not much reputational damage to the government fromnot acting when the private players are acting), when M is high (damage from a terrorist attack is high), and when the united front effect is not too powerful (a-b is small).

Proposition 2 *- From the private players' point of view, their level of effort increases with an increase in probability of attack ('p'), increases with an increase in loss in case of a successful attack ('F') and increases with a decrease in the probability of expenditure by the government on anti-terrorist activities ('α').*

Proof - See Appendix 2.

It is obvious that the private players will increase their level of vigilance in the case when there is a greater likelihood of attack and when the loss that they have to incur due to a successful attack is more.

The private players feel highly unsafe when they observe the government is not taking sufficient measures to avert any terrorist attack. So, they decide to increase their effort even if it is costly for them. In short, for the private players, 'e' and 'α' are substitutes. It can also be said that increased preparedness on the part of the government actually reduces private precautions.

Equilibrium levels of effort by the private players (e*) and probability of anti-terrorist expenditure by the government (α*).

'e' and 'α' are the functions of each other. From the propositions above, it is clear that from the private payer's perspective, 'e' and 'α' are substitutes, when from the government's perspective, they can be either complements or substitutes.

$\alpha = \{pe\,[a-b-c + E-M] + p\,[M+b]\}/2$ (From A1.1)

$\partial\alpha/\partial e = p\,[a-b-c + E-M]\,/2$

$\partial^2\alpha/\partial e^2 = 0$

So, the α(e) line be either positively sloped straight line (when a-b-c > M-E) or negatively slopedstraight line (when a-b-c < M-E).

$\{[2Fp(1-\alpha)]/3\}^{1/2} = e.$ (From A2.1)

$\partial e/\partial\alpha = -\,[Fp\,(1-\alpha)^{-1/2}]/3 < 0$

$\partial^2 e/\partial\alpha^2 = [Fp\,(1-\alpha)^{-3/2}\,]/6 > 0$

So, e(α) can be represented as a downward sloping convex curve decreasing at decreasing rate (as private players are cautious to first observe that government measures are sufficient as the losses from attack are very high)

Analysing these on a case-by-case basis to arrive at the equilibrium levels of 'e' and 'α'-

Case 1 - When from the perspective of the government, 'e' and 'α' are complements ($\partial\alpha/\partial$e ispositive), while from private player's perspective, they are substitutes ($\partial\alpha/\partial$e is negative).

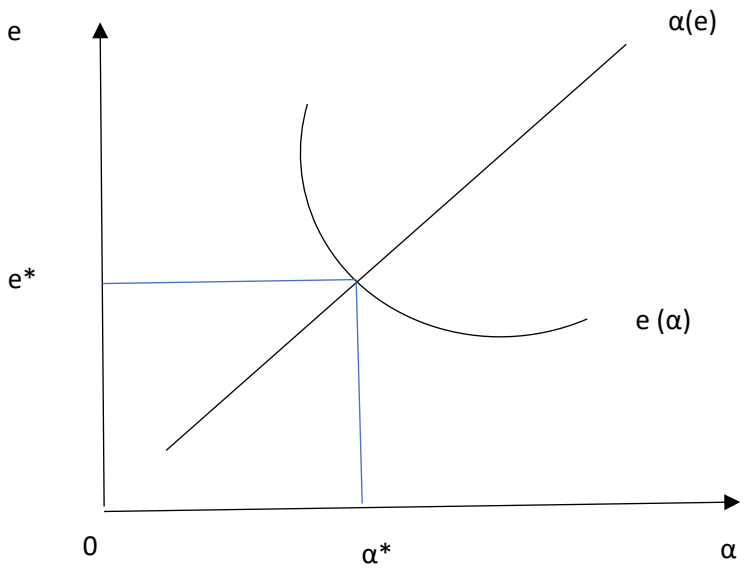

Fig 1- Equilibrium 'e' and 'α' when they are substitutes from the private player's perspective and complements from government's perspective.

e* and α* are the equilibrium level of anti-terrorist efforts by the private players and the governmentrespectively.

Case 2 - When from both the perspective of the government and the private players, 'e' and 'α' are substitutes ($\partial\ \alpha/\partial$e is negative)**.**

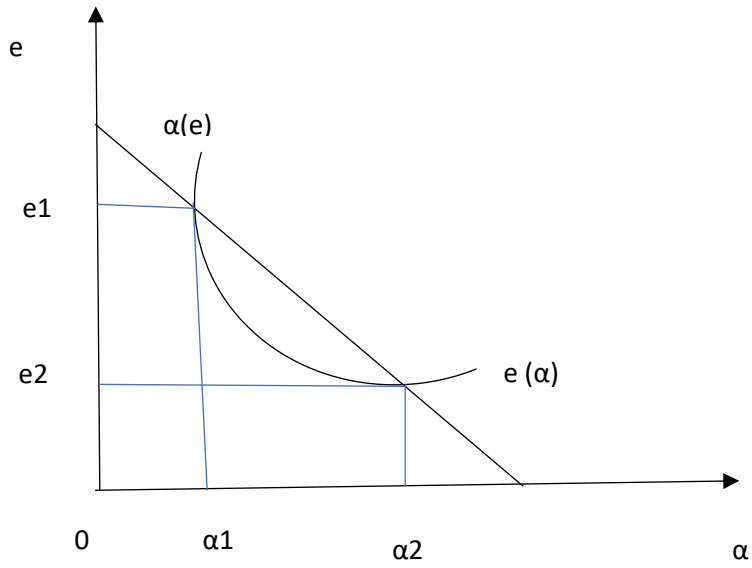

Fig 2- Equilibrium ‘e’ and ‘α’ when they are substitutes from both the private player’s as well as government’s perspective.

The above case represents a situation with multiple equilibria - E_1 and E_2. Here, the government would like to choose a low ‘α’ as long as it expects the private players to put in a high ‘e’ (E_1). Similarly, the private players would like to put low effort if they expect that the government has a high probability of undertaking a higher anti-terrorist expenditure (E_2). So, in this situation, both the parties will avoid committing high effort, hoping that the other party will make up for it.

Comparing multiple equilibria- E_1 and E_2-

Proposition 3 *- There can be multiple Nash equilibria. The multiple equilibria cannot be ranked.*

Proof- See Appendix 3.

For the private player, $E_2 > E_1$ as it provides a higher expected payoff. So, the private players preferto put a lower effort.

For government, $E_1 > E_2$ as it provides a higher expected payoff. So, the government prefers theprivate player to put a higher effort.

Since, for the private player, $E_2 > E_1$ and for government, $E_1 > E_2$, it is not possible to rank them.

None of them are Pareto superior.

As government makes the policy, it puts the resources into making people aware about beingvigilant. Vigilant citizens are instrumental in foiling terrorist attacks.

So, the policy prescription involves putting resources into making people aware about being vigilant that is on announcements, advertisements and social media campaigns.

4. Conclusion

No corner of the world has been insulated from attacks by terrorists in this third decade of the twenty-first century. The people around the globe are constantly living under the fear of such attacks. Under this scenario, this paper puts the problem of terrorism in a game theoretic framework. Taking the government and private players as rational economic agents, given an exogenous probability of a terrorist attack, it gives policy prescription.

The paper incorporates the fact that the private players play an important role in undertakingcounter terrorist measures by putting in effort in terms of being vigilant. In such a scenario, I model a simultaneous game between the government and the private players, given an exogenous probability of attack by a terrorist group. I have found that from the government's perspective, the probability of anti-terrorist expenditure by the government can be either substitutable or complementary to the private players' efforts; whereas from the private players perspective, these two are substitutes, that is, if the private players observe an increase in government's anti-terrorist measures, they will reduce their effort. In other words, increased preparedness on the part of the government reduces private precautions. When anti-terrorist efforts are taken as substitutes from theprivate player's perspective and complements from the government's point of view, unique equilibrium values of effort by the private players and probability of anti-terrorist expenditure bythe government are arrived at; (iv) when anti-terrorist efforts are taken as substitutes from both the private player's and government's perspective, then multiple equilibria exist. Each party has an incentive to free ride on the other. There is no pareto superior equilibrium in this case. The paper prescribes expenditure by the government on making people aware about being vigilant.

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Appendix 1

Expected payoff of the government-

$\alpha pe(a-H(e)) + \alpha p(1-e)(b-H(e)) - \alpha(1-p)H(e) + (1-\alpha)pe(c-E) + (1-\alpha)p(1-e)(-M) + 0$

$\Rightarrow \alpha pea - \alpha^2 pe + \alpha pb - \alpha^2 p - \alpha peb + \alpha^2 pe - \alpha^2 + \alpha^2 p + pec - peE - \alpha pec + \alpha peE - pM + pMe + pM\alpha - pMe\alpha$

(Because $\alpha = H(e)$)

Since the government chooses alpha to maximize its expected payoff, the first order condition givesus (differentiating with respect to "α" and setting the derivative equal to 0)-

$-pea - 2\alpha pe + pb - 2\alpha p - peu + 2\alpha pe - 2\alpha + 2\alpha p - pec + peE + pM - pMe = 0$

$\Rightarrow \alpha = \{pe [a-b-c + E-M] + p [M+b]\}/2.$ A1.1

Now, differentiating A1.1 with respect to 'e'

$\partial \alpha/\partial e = p [a-b-c + E-M] /2$

This can be positive or negative depending upon the relative strengths of a-b-c and M-E.

1. If a-b-c > M-E, then the government and private players' anti-terrorist measures are complementary from the government's perspective, as $\partial \alpha/\partial e$ is positive.
2. If a-b-c < M-E, then the government and private players' anti-terrorist measures are substitutable from the government's perspective, as $\partial \alpha/\partial e$ is negative.

Appendix 2

Expected payoff of the private players-

$\alpha pe(W-e^2/2) + p(1-e)W\alpha + (1-p)e(W-e^2/2)\alpha + \alpha(1-p)W(1-e) + (1-\alpha)pe(W-e^2/2) + (1-$

$\alpha)p(1-e)(W-F) + (1-\alpha)(1-p)e(W-e^2/2) + (1-\alpha)(1-p)(1-e)W$

$= W - e^3/2 - Fp + Fep + F\alpha p - F\alpha ep$

As private players choose 'e' to maximize this expected payoff, the first order condition gives us(differentiating with respect to 'e' and setting the derivative equal to 0).

$Fp - F\alpha p - 3e^2/2 = 0$

$\Rightarrow [2Fp(1-\alpha)]/3 = e^2$

$\Rightarrow \{[2Fp(1-\alpha)]/3\}^{1/2} = e.$ A2.1

It is clear from A2.1 that

1. $\partial e/\partial p$ is positive - The level of effort put in by the private players increases with an increase in probability of attack.
2. $\partial e/\partial F$ is positive - The level of effort put in by the private players increases with an increase in the level of loss that they have to incur due to a successful terrorist attack.
3. $\partial e/\partial \alpha$ is negative - The level of effort put in by the private players increases (decreases) with a decrease (increase) in the probability of anti-terrorist expenditure by the government. The private players view 'e' and 'α' to be substitutes.

Appendix 3

Comparing '$E1$' with '$E2$'.

$\alpha \varepsilon [0,1]$ and $e \varepsilon [0,1]$.$e1 > e2$ and $\alpha 2 > \alpha 1$

Taking $E1(e1, \alpha 1) = (1, 1/2)$ and $E2(e2, \alpha 2) = (1/2, 1)$

Expected payoff of private player= $W - e^3/2 - Fp + Fep + F\alpha p - F\alpha ep$

Checking at $E_1 = W - 1/2$ A3.1

Checking at $E_2 = W - 1/16$ A3.2

A3.2 > A3.1

So, for the private player, $E_2 > E_1$ as it provides a higher expected payoff. So, the private playersprefer to put a lower effort.

Expected payoff of government = $\alpha pea - \alpha^2 pe + \alpha pb - \alpha^2 p - \alpha peb + \alpha^2 pe - \alpha^2 + \alpha^2 p + pec - peE - \alpha pec + \alpha peE - pM + pMe + pM\alpha - pMe\alpha$

Checking at $E_1 = 1/2\ p\ (a+c-E) - 1/4$ A3.3

Checking at $E_2 = 1/2\ p\ (a+b) - 1$ A3.4

A3.3 > A3.4

So, for government, $E_1 > E_2$ as it provides a higher expected payoff. So, the government prefers theprivate player to put a higher effort.

Since, for the private player, $E_2 > E_1$ and for government, $E_1 > E_2$, it is not possible to rank them. Since government makes the policy, it puts the resources into making people aware about being vigilant.

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