

TERRORISM- A GAME THEORETIC APPROACH

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Abstract: Terrorism which has been on the increase in recent years is of much concern to both Governments and the private sectors. This research aims at reflecting the contemporary trends in international terrorism, and suggesting the possibility of their application for the Ghanaian private sector. Game Theory, which in recent years has been increasingly used in researches and in creating anti-terrorism strategies is the method of presentation of this write-up. Game Theory is rationally used to examine this phenomenon, and with the aid of economic instruments offer new remedies.

1. INTRODUCTION

It is of grave concern the rate at which terrorist activities are going on all over the world. Prominent among the recent attacks which has gained worldwide recognition include the happenings in France (Paris) and Belgium (Brussels). In Africa, recent terrorist attacks in Mali, Ivory Coast have been of a major concern to Ghanaians since Ghana shares its boundary on the west with the Ivory Coast. This has raised a lot of security concerns in Ghana necessitating the author to come out with such a piece of write-up.

Terrorism is mostly agreed upon and defined as a phenomenon that is designated as an act of violence applied to achieve the aims through fear and intimidation. Terrorism seems to be a phenomenon that influences public opinion significantly. The idea that terrorists are irrational thinkers moves toward deeper research of their motives and causes of conflict behavior and its modeling. "In the study of economics of defense these days, Game Theory is becoming of much importance. It is also useful in the study of conflict mediation, resolution, peacekeeping, arms races and arms trade (Sandler and Enders, 2004).

Questions that are related to fight against terrorism such as how terrorism attack can be defended effectively?, what are the costs associated with its defense and is it advantageous to dialogue with a terrorist group can be responded to rationally by game theory. "Current application of Game Theoretical methods in the study of terrorism include: evaluation of strategy, how funds are allocated by nations to fight terrorism, how after attack situations are dealt with, assessment of risks

associated with terrorism and determining whether a state policy of not negotiating with terrorists discourage these activities" (Fricker, 2006). This article brings into the fore the analysis of terrorism in a specific context of an economic context and also introduces Game Theoretical applications in researching about this canker.

TERRORISM AND RATIONALITY

The rationality of terrorists is assumed by the application of game theory to terrorism. Not everyone has acquiesced with characterizing terrorists as rational. As a result, defending this assumption is required before developing game theoretical models aimed at analyzing terrorism. Though rationality in colloquial usage invites diverse understandings, there is a precise definition by game theorists. Game theorists define rationality as calculating the costs and benefits of available choices in order to select the path leading to the greatest net gain.

Economists were the brain behind the utilization and use of game theory in developing analytical models. Their success story has been attributed in a large extend to the assumption and reliability that "money and the possibility of making a profit motivates people" (Scott, 2000). Adding to the fact that people are motivated by profit, observing economic variables serve as a contributory factor in accepting to use game theory for the purpose of economic analyses. Profit and loss, making determinations regarding rationality can easily be observed much easier in areas where motivations are visible. Benefits and costs have not always been vividly recognized for the purpose of adjudicating

rationality in the study of terrorism. This means there is an attempt at developing a proper understanding of the surrounding environment of terrorism for the purpose of determining whether rationality is present or not.

In a determined manner, religious, political or ideological goals motivate terrorist. However, reasons why one decides to employ violent methods in achieving these goals need not be desired. After all, there are available alternative means of achieving such goals even at a lesser cost to the individual. The costs include loss of lives, loss of time with family, loss of money, and disconnection from friends. Whether or not terrorists are rational can be observed from both conceptual and historical perspective. This is discussed in both contexts of the individual perpetrator and group. The perspective of the individual introduces additional challenges such as how to tackle the free-rider problem.

After all, "it appears perfectly rational at the group level: the contention of terrorists places great pressures on adversaries and increases the probability that the objectives of the group will be achieved" (Wiktorowicz and Kaltenthaler, 2006). However, in the case of the individual, would it not be more rational to "free-ride off the efforts of others rather than putting personal self-interest into jeopardy?" The acceptance that "we cannot judge an action as irrational merely because we disagree with the studied actor's preference ordering is important to our discussion" (Wiktorowicz and Kaltenthaler, 2006). The individual is acting rationally as long as he believes he is optimizing his preferences. Identifying his preferences ultimately becomes his challenge.

Several theories explaining the terrorist's choice of action have been developed. Some of these theories use sociological or psychological approaches to deal with explaining the decisions of terrorists. Jerrold Post states that, "as a consequence of psychological forces, political terrorists are driven to commit acts of violence" (Post, 1998). He went on to state further that his intention is not to suggest that the psychological mechanisms of externalization and splitting are used by every terrorist or all terrorist suffer from borderline or narcissistic personality disorders. He however holds a distinct impression that these mechanisms are found with highly great frequency in the population of terrorists, and contribute immensely to the uniformity of terrorist" (Post, 1998). Shughart (2004) stated that although most terrorists have younger ages, with the greatest majority being males, their education, race, ethnicity, employment or social status cannot be used to distinguish them from non-terrorist hitherto. Terrorists "take violence as a deliberate choice made by an organization for strategic and political, instead of as

an unintended outcome of social or psychological factors" (Crenshaw, 1986). Terrorists, apparently have no traceable roots to psychological difficulties in their childhood stages, genetic factors, identification with the underclass or disturbed family life. Terrorists are unique personalities with no existence of representative terrorist (Shughart, 2004).

In short, terrorists based on psychological or sociological profiles, defy categorization. Primarily, terrorists are not "uneducated, poor, social losers or immature religious zealots" with irrational proceeding (Pape, 2003). If there is the possibility of drawing any conclusion relating to how terrorist are generally classified, it could confidently be said that they "look like some sort of individuals who are politically conscious who might want to join a grassroots movement more than joining religious fanatics or wayward adolescents." On his further research on terrorism Pape, (2003) did not only reveal the strategic nature of terrorism but also challenged the problematic profiles of terrorists. The notion that terrorists are capable of acting rationally in the planning and execution of their attacks has been provided with greater support.

2. GAME THEORY

Game Theory is a scientific discipline that deals with decision making in conflict situations. Conflict situations arise in many instances. "In modern Game Theory, the concept of the game has a very general meaning, which does not only include the type of salon games such as poker or chess, but fundamentally any situation of conflict between individuals, armies, companies, political parties, states, biological species" (Fiala, 2008). Game Theory in order to perform critical analysis on situations uses not only mathematical apparatus, but also economics, sociology or psychology. The strategy is based on analysis of a set of decisions and situations. "Anyone who tries the strategic behavior should be clear in several cases" (Mares, 2003).

Another characteristic feature of Game Theory is the uncertainty in decision making. Valenčík (2006) defines Game Theory as a "theory of decision models under uncertainty, where an entity ("player") only has information about a number of possible situations, but not to all." The goal, an optimal choice of strategy, makes it necessary to respect the strategy and expected procedure of another player or players. Therefore, it is a specific situation where the players change strategies, create counter-measures and also interact. The participant or player may be an individual, couple or group. Players' decisions are implemented on the basis of

strategies. The application of Game Theory is in diverse areas such as using it in sociology, economics, biology, political science, and cybernetics. Game Theory also describes a number of particular phenomena notably competitions, interpersonal relations, war and political conflicts. Game Theory, from a historical perspective, can be identified in the works of ancient philosophers. The first modern development of Game Theory is associated with names of John von Neumann and Oskar Morgenstern, and their works from 1928. The study focuses on theoretical foundations of Game Theory and also performed the proof of basic theorem of matrix games, which is a mathematical theorem called minimax. Currently, Game Theory is being used in number of scientific disciplines such as economics, business, biology, political science or computer science.

Basic assumptions of Game Theoretical applications are that it has rational players, the rules of the game are known by all parties and finally players have an overview of the values in the game and know the amount of losses and gains (Pelis, 2004). One basic concept of Game Theory is general model - the game in normal form. Game in normal form is seen in three sets as shown below:

$((1,2, \dots, n), (S_1, \dots, S_n), (Z_1, \dots, Z_n))$

$(1,2, \dots, n)$ - set of players

(S_1, \dots, S_n) - set of strategies

(Z_1, \dots, Z_n) - set players gains

Natural numbers are used to number players. Important condition of this model is to differentiate between players and to know their numbers. At least two players are needed. Each i -th player has a strategy - S_i . The strategy is regarded as a description of how the player develops in the game and respectively elected as a sequence of steps during the game. If it is regarded as game in normal form, then the players' chosen strategy $x_i \in S_i$. All the strategy, which selects all the players in the game then determine the value of payroll function $Z_i(x_1, \dots, x_n)$ for the i -th player.

Distinction between the games can be done based on: i) number of players (with two as the minimum number of players. As usual, the maximum number of players is finite (the game with a finite number of players). ii) rationality of players (Game Theory, though is essential for rational behavior of individual players, there can still be two distinct extreme approaches. The first, "intelligent" player acts rationally. The other extreme is the player who selects random actions.) iii) strategies (Strategies can both be infinite and finite. If the player chooses real number intervals, it would be a game with infinite strategy. On the other hand if the game is considered as rock-scissors-paper, it is a game with finite strategies.) iv) cooperation (Games can be

grouped into uncooperative and cooperative. For non-cooperative is the basic assumption that individual players can not cooperate. They can build coalitions and negotiate further steps. Communication barriers can be given by the instances of the game, the environment where it goes or cooperation may be prohibited by regulation or law.)

2.1 Relevance of Game Theory in Understanding Terrorism

There are diversified approaches to model terrorism using game theory as a tool. Game theory, without doubt, is significant in understanding terrorism based on the following assumptions:

- Terrorists are motivated to form networks
- Origin states enter into binding agreements with terrorists due to incentives
- Efforts of counter-terrorism have the likelihood of been defensive
- The tension in target societies increases because of the efforts of counter-terrorism
- Efforts of proactive counter-terrorism work only if terrorism is totally replaceable by the political activities of others, but involve a complex mechanism of threats and counter threats between governments and former leaders of terrorist.

Although political scientist or historians will have trivial understandings of these findings, the formulation of the different relations in the game theoretical set-up becomes the merit of game theory. If the characteristics of terrorist assuming rationality are explained by game theory, we will be hopeful of finding rational counter-terrorism strategies. Further developments can also be predicted. "Predictive power for future events is claimed by game theory, estimating both from laboratory experiments of the behaviour of non terrorists playing unnaturalistic games and from post hoc analysis of real world incidents" (Enders and Todd, 2006)

Game theory, though explains mechanism, results and strategies in the game, why some people enter the game is not explained. Undeniably, on the side of the target states, this is an involuntary decision. Regarding terrorists, game theory offers no explanation on their motives.

2.2 Economic Context of Terrorism

Generally terrorism refers to a "Premeditated use or threat of extreme violence to achieve political or other goals through fear and intimidation aimed at the public" (Sandler and Enders, 2004). The definition is made up of two basic parts. The first being selected targets. If it isn't for political (religious) goals, then the violent attacks can't be considered as terrorist, but instead as a violent crime. Another significant part is the use of

extreme violence that leads to increasing brutality of terrorist attacks. This may be due to getting more publicity, prestige, promotion, or recruit new supporters and members.

The classical view of terrorism makes it possible for it to be studied more in economic context in recent years. In the U.S. Congress, the Joint Economic Committee defined the costs of terrorism as "loss of human capital, uncertainty in the behavior of investors and consumers, restrictions in specific areas or sectors, increased security costs (tax on terrorism), and anti - terrorist expenses that displace productivity" (Saxton, 2002). This definition can be grouped into two. Apart from the destruction of lives during terrorist attacks, it also damages property and infrastructure. This shows that aside the loss of precious human lives, there is also the loss of productivity by most economies that are associated with terrorism. Loss of property and infrastructure include its primary destruction as well as the costs of remediation and repair. Due to the atmosphere of uncertainty and fear created by the activities and threats of terrorist, consumption and investment also reduces. Abadie and Gardeazabal (2008) indicated that even if the activities of terrorist are only a small fraction of the country's economic risk, their impact on the reduction of direct foreign investment is considerable. It impacts indirectly on the economic systems. An instance of a direct negative impact can be seen on tourism or air travel. Organizations that are directly affected by the impact of terrorism must not only increase the cost of safety but also lose customers. It impacts indirectly by affecting the whole society in terms of higher insurance, increasing transport costs and travel delays.

Terrorism undoubtedly has an impact on the economy of a nation. Abadie and Gardeazabal (2008) in their work titled Terrorism and the World Economy reported four major areas that terrorism affects such as the Capital of country (directly affected by reducing terrorist attacks), increased uncertainty as a result of threat of terrorism, cause of higher spending on security (resource allocation from the productive sector to be use for security reasons) and its adverse effects on some sectors of the economy such as tourism.

Even though there exists many diverse ways and views on the definition of terrorism and its corresponding appearance to various approaches, scholars have identified and agreed with most definitions as: i) Terrorism as form of aggression against targets, no - aggressors (governments, politicians, civilians, companies, infrastructure). ii) Primarily, military objects are not the targets of the attacks and the goal is not victory in war iii) The act of terrorism is in itself, not the goal of terrorists but rather getting attention, attitudinal change or change in opinion. Therefore, it is important to identify the target of violence and the real aim of

terrorists. iv) Creating an atmosphere of uncertainty and fear is only a way of achieving goals. v) High spending on security is related with terrorism (Eldor and Rafi 2004).

Frey and Luechinger (2003) identified three ways of using indifferent analysis to deal with how the level of terrorism can be reduced through economic instruments. First and foremost is increasing the cost of terrorism, the second is reduction of benefits of terrorism and the third increasing the benefits from the activities of non-terrorists. He assumes that terrorists can achieve their goals using terrorist (T) non-terrorists activity (L), while non-terrorists activities are legal ways to achieve goals. The source of terrorists is represented by budget line, points on indifference curve represents a combination of illegal and legal activities that are used to obtain political or other goals. The achievement of goals is done by the combinations of various illegal and legal practices. The three anti-terrorism strategies are all aimed at the highest rate of substitution of making illegal activities legal.

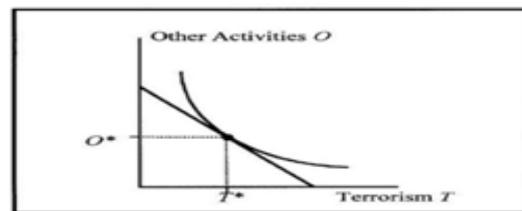


Image 1: Decision Calculus of Terrorists
Source: Karsten Wenzlaff (2004) Terrorism: game theory and other explanations

As a prerequisite for the first strategy, if state or other possibly endangered entity increases the cost of the activities of terrorist, legal activities will be substituted by the terrorists. Such cost could be increased in an attempt to improving security measures which pushes the line of the budget to left. Accordingly the indifferent analysis of the activities of terrorism will be minimized and replaced by legal activities.

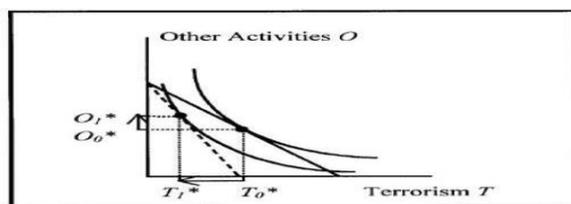


Image 2: Increasing Costs of Terrorism
Source: Karsten Wenzlaff (2004) Terrorism: game theory and other explanations

The second strategy is based on reducing the merits of the illegal activities of terrorist. Terrorism is merely a way of getting terrorists' attention in order to achieve goals. If the damage caused by terrorism is reduced by the attacked subject, there is an upward shift in the indifference curve line

which will again lead to substitution for illegal activities to be legal. A typical example might be higher degree of decentralization of threatened structures, which is less affected by attacks.

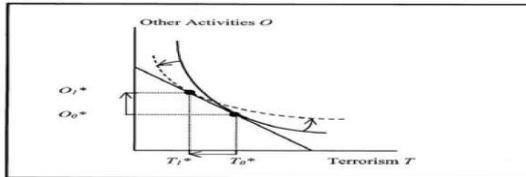


Image 3: Reducing Benefits of Terrorism
Source: Karsten Wenzlaff (2004) Terrorism: game theory and other explanations

The third way by Frey is increasing the benefits from legitimate activities. Attacked subject usually the state, should be in conformity with this strategy in order to give terrorist groups the chance to participate in political decision making. This will bring legal actions of terrorists by increasing the benefits.

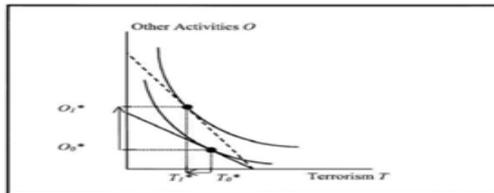


Image 4: Reducing Costs of Other Activities
Source: Karsten Wenzlaff (2004) Terrorism: game theory and other explanations

3. TERRORISM AND GAME THEORY

Research on the application of game theoretical methods on terrorism started when the model of negotiations between the state and terrorists was introduced by Sandler and Enders (2004). The model points out that terrorists' behavior and capabilities depend on how they will respond to the apparatus of the state and vice versa. After the September 11th issue in the U.S, terrorism started to be intensively studied using Game Theoretical approaches. The rationality of the decision-making of terrorists was shown by the successfully planned and carried out attacks. One of the basic assumptions of Game Theory is the rationality of actors and the choice of strategies. An example is the metal detectors' installation at airports in 1973 and the associated immediate substitution of kidnapping people primarily politicians, diplomats and senior government officials instead of planes being hijacked. When kidnappings are prevented by increased costs of security, terrorists substitute it with suicide attacks. Game Theory is an appropriate tool in researching into terrorism because the interaction between terrorist organization and attacked subjects is captured when there are interdependent steps that cannot be analyzed differently (Enders et al 2009). The subject in the terminology of TH player is such that it maximizes its benefits.

Game Theory is a useful tool for research on terrorism because it captures the act of terrorists

and governments as interdependent, sees terrorist and Government as rational actors who reply to opponents steps, that terrorist and Government behave in order to acquire a strategic advantage, that terrorist and Government are rationally trying to maximize their benefits and finally that terrorist and Government make decisions on information that is incomplete (Sandler and Arce, 2003).

The design of future anti-terrorism policies can also be tackled by Game Theory. Sandler and Arce (2003) outlined in their model whether or not the government should accede to the demands of terrorists. The U.S. government's counter-terrorism policy has a generally known slogan as "no concessions to terrorists." Conditions that result from the application of Game Theory are added by authors. To begin with, it reflects the position of the government that it is always tough to be at this point. The next conditions are that the information of terrorist is incomplete about the counter-terrorism policy of the government.

Game Theory is also important in the implementation of security measures among countries. Game Theory is also used by Sandler and Arce (2003) to describe what they termed "races in intimidation" among countries. Potentially, there are two countries of high vulnerability by one terrorist group. In case security costs are increased by a country, the associated cost of terrorist attacks also increases. But since the costs of the attacks of terrorist in the other country are relatively declining, it represents a negative externality of the other country. As a consequence, the second country raises its cost of security, because it aims at minimizing the probability of being attacked as an alternative target. If the other country decides to raise its security measures with the associated costs above the first country, the negative externality is poured on the first one. This instance points out that the necessary cost to ensure the safety of countries is overestimated.

3.1 Game Example on Terrorism

The prisoner's dilemma is the most probably, classical and often discussed example of the use of Game Theory. It is made up of scenarios where the crime was committed and there are two suspects, A and B arrested. There is incomplete evidence which makes it difficult to prove the crime to both potential suspects. Both suspects are separately interrogated where A do not know how to decide B and vice versa, with both suspects offered the following options: i) If one suspect decides to confess with the other failing to do so, then the confessor will be given a year. The one who confesses not will be arrested for 10 years. ii) Both suspects will be arrested for seven years if they both confess and iii) Both will be arrested for three years if they fail to confess.

Tab.1 Prisoner's Dilemma

		A	
		confess	not confess
B	confess	7,7	1,10
	not confess	10,1	3,3

Source: Sandler and Arce (2003). Terrorism and Game theory

The decisions in terms of prisoner A will first be examined. Prisoner A is unaware of how prisoner B will respond in trying to maintain an advantageous result to him. The possibilities in the matrix point out that prisoner A is advantageous to also confess if prisoner B confesses. In this situation, a penalty of seven years will be given. If he fails to confess, ten years penalty will be given. If prisoner B decides to confess not, prisoner A again has an advantage to confess, because prisoner A's judgment will just be for a year compared to the three years sentence he will be condemned to if he fails to confess.

The same decision will be chosen by prisoner B. When both confess, they will each be given seven years imprisonment. If there is no confession, both will be sentenced to three years imprisonment. The dominant strategy is confession. This strategy is closely linked to Nash equilibrium, which arises: "If the best strategy, that is the dominant strategy, is followed by each player for him or herself, while if there is a deviation from it and the second player (if there are more players other than a player), the dominant strategy will be kept, which would be worsened (Enders and Todd, 2000). Prisoner's Dilemma is the situation whereby players in the game being it individuals, firms or states follow their dominant strategy, which affirms to the fact that, ultimately, these players can be worst off. States deciding whether to be in conformity with agreement on arms or companies that comply with agreements can use prisoner's dilemma. Sandler and Enders (2004) applied the prisoner's dilemma situation to instances where governments have to choose between reactive and active policies of counter-terrorism. Active policy which is all about an open and active fight against terrorism mainly consists of a search and destruction of terrorist, destroying the infrastructure and resources of terrorists, monitoring the activities of terrorist actively and preventing the actions of terrorists as well as their sponsors. If a state implements an active anti-terrorism policy and it tends out to be successful in destroying the cell of terrorist, there is the possibility of other states relying on the active actions of such a state. In such instances it is termed free-rider effect when the costs and danger related with the active fight against terrorism burdens one state, whilst the other states become mere beneficiaries of it. In particular, active policy

is characterized by solving the effects of the acts of terrorism. The following matrix is illustrated by the prisoner's dilemma in a free-rider effect.

Table 2. Application of Prisoner's Dilemma

		EU	
		active	reactive
USA	active	2,2	-2,4
	reactive	4,-2	0,0

Source: Sandler and Arce (2003). Terrorism and Game theory

The U.S. and the European Union (EU) are the two players. Both countries are faced with common threat of potential attacks by terrorist, and as such must agree on whether or not to apply active counter-terrorism policy jointly. The assumption is that active policy for individual countries obtains benefits of 4 and costs of 6 for countries that apply an active policy. If the U.S. applies active policy and the EU gets benefits associated with it (free-rider effect), then the EU will gain the advantages of the 4. The U.S. gets negative 2 ($4 - 6 = -2$). Cost of 6 shall be subtracted from the benefits of 4. The benefits are otherwise reversed if the U.S is a free-rider. If an active policy is used by both countries, then the benefit of 2 ($6 - 2 \times 4$) is gotten by everyone. The prisoner's dilemma game is the result, through which no country would like to apply the policy of active counter-terrorism.

3.2 Application of Game Theory

Authors consider national or global range in dealing with the application of Game Theory in creating counter-terrorism strategies. There is the existence of a new area in the use of this theoretical framework for regional and private sector. The subject of research is arguably one of the largest chemical producing companies, Kinapharma Industry Limited, a well known chemical manufacturing industry located in the central business town of Accra, the capital of Ghana. Its chemical production is predominantly based on pharmaceuticals, pigments, acids dyes, solvents, acids and others. An attack by terrorist on this industry will impact directly and greatly on its immediate environment and beyond.

The research was carried out in collaboration with Kinapharma Industry. Primary data was collected from the security experts and documents of the company. Focusing on the Ghanaian business sector and with the use of Game Theory, sizeable amounts of merits are brought to both Ghanaian nationals and the international world. One major advantage is the choice of creating a specific potential conflict situations and description of game players. Creating of security strategies must be

made and preceded by detailed research of participants (players) namely, the company and terrorist. In actual sense, other players, such as police, government authorities, international organizations and others can be assumed to be participants.

But for the purpose of this write-up, only two players – the company and terrorist (terrorist group) are considered. Subsequently, the research and analysis of the Ghanaian security reality are the basic prerequisite to identify possible threats. It is of much importance to offer the threat of domestic extremism and terrorism (the first player) a major focus. The Ghanaian security situation is defined as relatively quiet in terms of international terrorism. There are specified major currents of extremist activities, their forms, characteristics and methods. The analysis point out that extremism (terrorism) in the Republic of Ghana is mainly represented by extreme-left and extreme-right wing political parties. Both have the likelihood to radicalization. The company is the second player. When there is a direct cooperation between staff and management, there is the possibility of an empirical research in the area of studying the strategic documents to provide adequate data for future description and analysis. Applying the theoretical framework of Game Theory serves as a security and defensive strategy in preventing the attack of terrorist. Although there are used concrete date, results of security strategy and recommendations during the testing of hypothesis and the development of a strategy, its generalization and application cannot be under estimated.

4. CONCLUSION

Due to the September 11 attack in the U.S, there has been a dramatic increase in the need to examine extremism and terrorism. Recent terrorist activities in countries such as France, Belgium, Mali, Ivory Coast have become more of a threat to the international world and governments of such countries not forgetting the citizenry. In recent years, Game Theory gives an increasingly deeper look at the relationships between terrorists, governments and other targeted subjects in the world. Studying the canker of terrorism is not solely the motive of Game Theory but also helping governments and politicians with an effective tool to create better and more potent counter-terrorism strategies. New areas of research on extremism and terrorism are opened by the opportunities to present difficultly measured data using values of number with subsequent modeling. This article aims at highlighting the issue of extremism and terrorism in an economic context and introducing Game Theory as an effective tool in adopting strategies to combat terrorism.

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