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Content

1. Introduction and research question 3

2. Literature Review 5

2.1. Terrorism research in general 5

2.2. Hostage-taking 6

3. The model 10

3.1. The one-shot game 10

3.1.1. Players, actions, types and preferences – explanations 11

3.1.2. Players, actions, types and preferences – formal notation 12

3.1.3. The perfect Bayesian Nash equilibria 16

3.2. The two period game 18

3.2.1. Are the two one shot equilibria still equilibria of the repeated version? 20

3.2.2. Does a killer want to build up a reputation of being a kidnapper? 25

3.2.3. Is choosing to bargain in the first period still an optimal action? 27

4. Results and conclusions 28

5. References 30

6. Appendix 32

6.1. Abstract (German) 32

6.2. Abstract (English) 33

6.3. Curriculum Vitae 34

1. Introduction and research question

Terrorism has been analyzed from many different perspectives. For instance social scientists, political scientists and also economists have taken interest in the topic. While no discipline alone might stand a chance to understand and explain terrorists' behavior, the insights received from the diverse academic branches have enlightened the research on terrorism. The economic perspective, while disputed by some, has multiple advantages to shed new light on the issue. Nevertheless it has to be stated at this point that the research is far from being advanced enough yet to draw policy implications. Therefore the investigation of the topic is even more important, to improve the existing models and create new ones, which model the world more realistically and provide useful advice for policy makers.

Defining terrorism is a more complex task than one might think. Numerous definitions exist, but there is little consensus on which should be preferred. However, the main components included in most definitions are the use of violence and frightening of the public to achieve political goals (van Um, 2009), where political objectives are the main distinction to crime in general. At this point the overall goal of research on terrorism has to be defined. While other authors may list different reasons, I believe that the main objective of this research should be to provide recommendations for policy makers how to design optimal policies to cope with terrorism.

Game theory as economic tool can provide new insights to this research area, due to the fact that it can analyze the existing strategic interactions between governments and terroristic groups. While the rationality of terrorists is a crucial assumption underlying the game theoretic approach it is also highly contested. However, empirical support for the rational actor approach has been provided. Terrorists seem to act optimally according to their specific goals and preferences and respond in a predictable fashion to changes in their constraints (Sandler, Scott, 1987). Terrorists' preferences, which may seem evil and not rational to non-terrorists, are not discussed by the rational actor approach. Rationality simply implies optimal behavior according to preferences. Even if those preferences seem irrational.
Also critics of the concept could not reject hypotheses that terrorists act rationally. Van Um (2009) states that no other concept could be found to better explain terrorists' behavior and terrorists seem to be at least boundedly rational.

The model presented in this thesis focuses on hostage-taking, a small, but important branch of terrorism. Very few theoretical models analyzing optimal strategies in hostage-taking situations exist. I construct a game theoretical model of hostage-taking based on a model by Nax (2008), to analyze the question how reputation considerations change the behavior of agents in hostage-taking incidents.

The rest of the thesis is organized as follows, first I give a short summary of the research areas and findings from the relevant literature, then the model is presented and the reputation effects are analyzed. The final section concludes and possible extensions are discussed.

2. Literature Review

To provide a better understanding of where to position my model in the existing academic literature I present a brief overview of the theoretical and empirical work on terrorism with a strong focus on hostage-taking. First I introduce a summary of the main fields of interest for research on terrorism from an economic perspective, followed by a more detailed analysis of the investigations done in the area of hostage-taking. There I state some empirical findings and concentrate then on the theoretical models, which are still not numerous.

2.1. Terrorism research in general

Game theoretic analysis of terrorism has evolved since the early eighties. Starting with Reinhard Selten's paper "A simple game model of kidnapping" (1976) an increasing interest in the economic approach to this topic can be observed. The peak of attention in the issue appears after the terroristic attack on the twin towers in New York in 2001. Even though the interest seems to have decreased since then, it is becoming more important again. Terroristic attacks as global problem and internationally operating terroristic organizations constitute an increasing threat for many countries.

Terrorism research from an economic perspective can be generally distinguished into three different research areas, namely counter-terrorism policies, suicide terrorism and hostage-taking, whereat counter-terrorism seems to be the most investigated topic of those three. Different approaches have been taken to analyze counter-terroristic spending choices for the government concerned with deterrence measures and pre-emption. While deterrence of terroristic attacks can be defined very generally as spending resources on prevention of the success of terroristic attacks (e.g. installation of metal detectors), pre-emption refers to weakening terroristic organizations in general, for instance by targeted killing of their leaders. It has been shown that deterrence measures can lead to over or under spending if multiple countries are involved in transnational terrorism (see for example Cadigan, Schmitt, 2010; Sandler, Siqueira, 2006). Therefore inefficient spending decisions are being taken. Also, the choice on which targets to spend deterrence resources is crucial,

since the protection of a possible target has often negative external effects. For instance the introduction of metal detectors on airports has led to a shift away from skyjackings to other forms of hostage-taking (Enders, Sandler, 1993).
Pre-emption analysis has provided insights on the effectiveness of this policy. There seems to be consensus concerning the hypothesis that pre-emption alone is not sufficient. Thus, an optimal mix of deterrence and pre-emption policy is investigated (see Bandyopadhyay, Sandler, 2009).

Suicide bombing is a quite new form of terroristic attack compared to other terroristic modus operandi and so is the research in this field. Existing models and theories in this research area are especially controversial due to the fact that the rationality of suicide bombers is highly contested. Nevertheless, the disastrous impact a successful suicide attack can have as well as the increasing number of suicide bombings as form of attack of terroristic groups (Sandler, 2009) provide arguments for the importance of analyses of this topic.

Hostage-taking, while less investigated than counter-terroristic strategies, is a crucial field of terrorism research. Game theoretic analyses of hostage-taking provide useful insights on optimal reactions of governments confronted with potential and actual hostage-takings. Furthermore, the fact that this area is somehow less investigated creates possibilities for research to provide entirely new insights in the matter.

Also, smaller fields of interest in the economic analysis of terrorism are terrorist networks, roots of terrorism, the time dynamics of terroristic attacks and international cooperation for counter-terrorism measures (Sandler, 2009).

2.2. Hostage-taking

The model presented in this thesis introduces a game theoretic approach to hostage-taking. Due to the fact that this research field is not as heavily analyzed as others, it is a fruitful possibility to receive new insights. Starting with the paper by Selten (1976) mentioned before, few theoretical models have evolved. Approximately ten years ago only three game theoretic approaches to hostage-taking existed (Sandler, Enders, 2004). The number has grown since, but theoretical models are still scarce.

When analyzing the relevant literature the first striking finding is that very few authors investigate these topics and therefore most papers have been written by only a couple of authors. The existing literature contains analyses of different aspects of hostage-taking. For instance theoretical and empirical investigations of the length of incidents (Atkinson, Sandler, Tschirhart, 1987) and the factors influencing logistical and negotiation success of hostage-taking (see for example Gaibulloev, Sandler, 2009) have been undertaken. Where empirical evidence has been provided that essential determinants influencing logistical success are resources and target vulnerabilities, factors determining negotiation success are the relative bargaining strength, hostage numbers, incident length and casualties (Gaibulloev, Sandler, 2009). The length of incidents is found to be increased by bargaining costs (Atkinson, Sandler, Tschirhart, 1987).

A pressing and still unanswered question is addressed first in a paper called “To bargain or not to bargain: That is the question” by Lapan and Sandler (1988). The authors focus on the question whether it is optimal for governments to commit to a strategy where they never negotiate. Since this never-negotiation policy is on the political agenda of some countries (e.g. the US), the question arises if it is optimal. The authors present a sequential game theoretic model where the affected government first chooses a level of spending on deterrence which influences the logistical success of an attack. Then, if a logistically successful attack occurred the government chooses to concede or not. Results from the theoretical model suggest that commitment to a never-negotiation strategy, or in other words, building up a reputation to never concede might be optimal in a multi-period version of the game. However, there persist certain shortcomings of the results of the model. A detailed analysis of the multiple-period model is missing. Furthermore, the optimality of the pledge to never negotiate depends on following unrealistic assumptions (Sandler, 2009): First, government’s spending on deterrence can be sufficient to deter all attacks. But even though some countries commit to a never-negotiation strategy and spend vast amounts of resources on deterrence, terroristic attacks occur. Second, the promise to never concede is fully credible, meaning that the government always experiences higher costs when conceding than when not. However, this depends on the dimension of the attack and especially on which and how many hostages have

been seized. There might be a problem of time inconsistency with this pledge, therefore making it not fully credible. Third, there is no uncertainty concerning payoffs, which is unrealistic. Neither terrorists nor governments have complete knowledge over resources of the counterpart. Furthermore, governments do not know which hostages could be taken and thereby the costs cannot be anticipated. Fourth, terrorists only gain from fulfillment of their stated demands. This assumption is unrealistic due to the fact that terroristic groups tend to carry out attacks not only to achieve a concession but also for other reasons. Media attention for dissemination of their overall political aim seems to be an even more important goal of terroristic attacks (e.g. the attack on the twin towers in New York 2001 was as well a suicide attack as a hostage-taking, with one of the main objectives being to receive media attention). Furthermore, the destabilization of the political system and the economy seem to be important goals pursued by terroristic groups (see for example Frey, Luechinger, 2002).

Some attempts to model hostage-taking excluding those unrealistic assumptions have been undertaken. For instance, Sandler and Arce (2003) present a theoretical model with asymmetric information for the government thereby excluding the assumption of certainty over payoffs. However, a somehow different question is analyzed in this paper, concerned with the offer a government should make to hostage takers, given that it does not know if it faces hardliner or moderates and where conceding to the demands of a moderate terroristic organization can lead to more violence. Another approach has been taken by Sandler, Tschirhart and Cauley (1983). The authors present some hostage-taking models with a rational actor approach to analyze the negotiation process between affected governments and terrorists, where uncertainty is also part of the models. The results suggest that never-negotiation strategies are not always optimal. This depends on risk preferences of terrorists.

Reputation effects in hostage-taking scenarios are investigated in a paper by Nax (2008), on whose work the model that is presented in this thesis is based. By excluding the unrealistic assumptions mentioned above the model provides an important contribution to the existing literature. Uncertainty of payoffs is generated by asymmetric information for terrorists and governments. Furthermore, the existence of different types of terrorists and governments ensures that terrorists do not only profit

from fulfillment of their demands, governments cannot deter all attacks and their pledge to concede is not always credible. The sequential model, where the concerned government chooses to concede or not only if the terrorist chose to take hostages, provides possible outcomes, where the government chooses to play a non-negotiation strategy.

Repeated scenarios are not investigated in detail in Nax's (2008) model as well. Generally it can be stated that game theoretical models on hostage-taking mainly disregard specific analysis of repeated interaction. However, single, one period encounters between terroristic groups and governments are hardly observed. Due to these modeling shortcomings of the existing models, I believe that the literature is not advanced enough to provide policy recommendations. Therefore I feel it is important to press on with the theoretic modeling in this area to eliminate unrealistic assumptions and other shortcomings of the existing models to reproduce the world more realistically. In this thesis I present a two period, altered version of Nax's model to study reputation effects in a repeated setting.

3. The model

Nax first published the paper "Modeling Hostage-Taking: On Reputation and Strategic Rationality of Terrorists" in 2008, where he presents a game theoretic model of reputation building in hostage-taking situations. The game has five perfect Bayesian Nash equilibria. Nax states "…*according to the folk theorem, all equilibria, and even all convex combinations between them, are possible in an infinite horizon*[1]". While it is generally true that all one-shot equilibria and all convex combinations of them can be sustained in an equilibrium of the repeated game, the game he presents is one of imperfect information and learning and therefore the standard folk theorem cannot be applied. Learning about the types of players changes the informational structure. Thus the one-shot equilibria do not necessarily need to form equilibria in the repeated model.

Nax's model describes an interesting approach to the topic of hostage-taking, but his model lacks more detailed analysis of the repeated interaction. I construct a model to analyze the different equilibria that can occur in a repeated version of Nax's game. Especially I investigate if the one-shot equilibria indeed remain equilibria, or if learning and reputation building changes the outcome. Furthermore I want to find which new equilibria can be constructed due to reputational effects. Therefore I extend Nax's model, after a few alterations of the one-shot version, to a two period game. In this chapter I present the basic model, its equilibria and the changes repeated interaction implies.

3.1. The one-shot game

In this game of incomplete information, there are two players, one government and one terrorist. I do not argue that either the government or the terrorist is a single person, but that they can be viewed as such in the model. Usually large terroristic groups and vast government machinery are involved in decision-making processes. But since only one action can be observed, they can be regarded as one person. Furthermore I want to elaborate shortly on why I only consider two players and not multiple governments and terroristic groups. This has first of all simplification

[1] Nax, 2008, p. 165

reasons. Secondly, large groups of terrorists who operate for long time spans exist (e.g. al-Qa'ida) and many terroristic organizations only operate in one country. Therefore an intuitive justification for the assumption of only two large players can be provided. A further extension of the model could include more terroristic groups in the game. But for the present analysis of reputation building I claim that two players are sufficient to study reputational effects.

3.1.1. Players, actions, types and preferences – explanations

First, this subchapter presents an intuitive explanation of the game structure. In the next section the notation and formal analysis are provided.
In this sequential game the terrorist moves first to choose one of two possible actions, to take hostages or not to take hostages. After hostages have been seized the government can either bargain or stay firm. Where staying firm implies no negotiations, bargaining denotes fulfillment of the terrorist's demands and does not mean haggling. The game ends if no hostages are being taken, or after the government moved.

Both players can be of one of two types. The terrorist can be either a killer or a kidnapper. The kidnapper type only wants to take hostages if he believes that the government will bargain afterwards, because he is only interested in the payment of his ransom. The killer type, on the other hand, optimally always takes hostages since it is his dominant strategy. Furthermore the killer always kills his hostages even if his demands are fulfilled. This radical type of terrorist may sound unrealistic, but studies show that some terroristic groups are led by other motives than ransom, e.g. scaring the public, media attention[2] and destabilizing the persisting regime (see for example Frey, Luechinger, 2002).
The government can be either strong or weak. Where strong and weak shall not be regarded as judgmental, but are just supposed to differentiate the two types in a distinctive manner. The strong government also has a dominant strategy, namely staying firm, whereas the weak government only wants to bargain with the kidnapper,

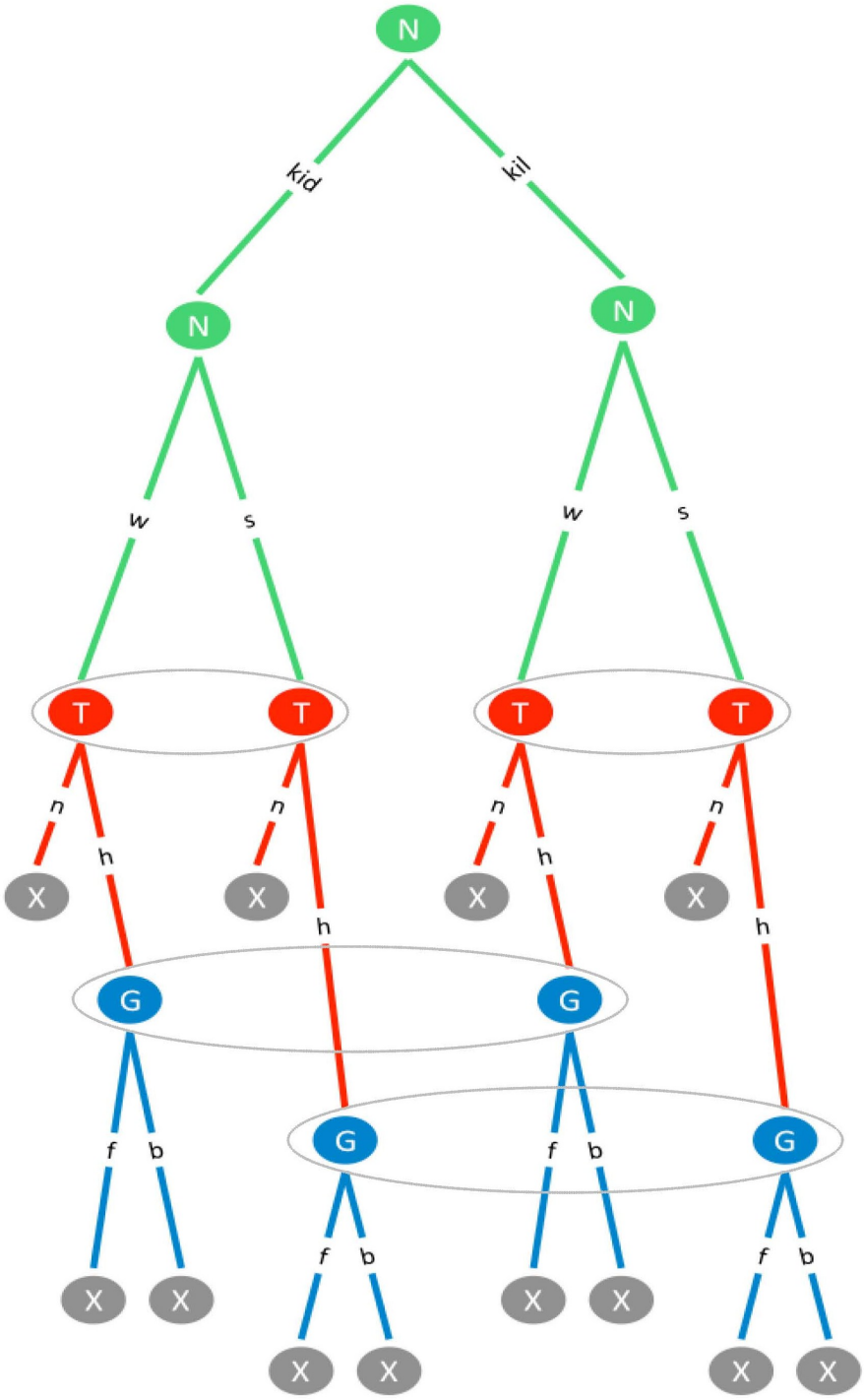
[2] From a purely game theoretic point of view scaring the public and media attention could be tools to increase future payoffs. Furthermore, since only actions are observable, motives cannot be explicitly modelled, but are contained in the payoffs. From a political, sociological and psychological perspective, however, media attention for recognition of the terroristic organisation's political cause is an accurate motive and can therefore be deterministic for preferences.

but not with the killer, since the killer kills the hostages anyway, even if bargaining took place. An intuitive explanation for the strong government could be that fulfilling the demands of a terroristic group would have strong political disadvantages (e.g. the government will not be elected again, because the public does not believe it is strong enough to lead the country if it negotiates with terrorists).
Even though these types of the terrorist and the government may seem extreme, the assumption of those types may be relaxed in an extension of the game, by including a continuum of types (including intermediate ones). As stated above this model brings the research on hostage-taking one step further in modeling the reality more accurately, by including a second period. Therefore certain assumptions need to be kept in the present analysis of reputation effects in a multiple-period setting.

Three possible outcomes of the game exist: No hostages have been taken, hostages have been secured and the government bargained or hostages have been taken and the government stayed firm. The terrorist's payoff depends on his own type and the actions chosen by himself and the government, but are independent from the government's type. If no hostages have been taken, the government receives a payoff, which is independent of his opponent's type. This also holds for the case when hostages have been secured and the government stayed firm, due to the fact that both types of terrorist kill the hostages if no bargaining takes place. If however, hostages have been seized and the government bargained, it has different payoffs depending on the type of the terrorist. Bargaining with a kidnapper is better than with a killer, since the killer kills the hostages even if the government concedes. The formal analysis follows in the next subchapter.

3.1.2. Players, actions, types and preferences – formal notation

Explicit notation of the game including players' actions, types and preferences are presented in this section.
The terrorist (T) can either take hostages (h) or not (n). Furthermore, he can be of one of two types, either a killer (kil) or a kidnapper (kid).
The government (G) can either bargain (b) or stay firm (f) once hostages have been taken. The possible types for the government are strong (s) and weak (w).



To introduce the types into the game tree it is common practice to let an additional player called ‘nature’ move first and decide with certain probabilities the types of the players. After nature moved it is the terrorist’s turn to choose an action, without knowing the type of the government. Observing the terrorist’s choice, the government can update its beliefs over the terrorist’s type and choose an optimal response. The game ends at one of the endpoints denoted by X.

Preferences over actions and outcomes:

Utility of type i of player j for outcome (x,y) is denoted by $U_j^i(x,y)$.

a. The terrorist: It should be obvious that both types of the terrorist will prefer in general that the government bargains.

The killer type: Taking hostages is a dominant strategy. If he does not take hostages he is indifferent about the government's choice of action.

$U_T^{kil}(h,b) > U_T^{kil}(h,f) > U_T^{kil}(n,b) = U_T^{kil}(n,f)$

The kidnapper type: prefers to take hostages only if there is bargaining afterwards, otherwise he prefers not to take hostages. If he does not take hostages he is indifferent between the government's possible actions. Taking hostages and staying firm is the worst outcome for him.

$U_T^{kid}(h,b) > U_T^{kid}(n,b) = U_T^{kid}(n,f) > U_T^{kid}(h,f)$

Since not taking hostages yields the same utility level for both possible actions of the government it will henceforth be denoted by $U_T^{kid}(n)$.

b. The government: favors no hostages are being taken over hostages are being taken for both types in general.

The weak type: prefers bargaining to staying firm against a kidnapper and staying firm to bargaining against a killer.

$U_G^w(n) > U_G^w(h,b) > U_G^w(h,f)$ against a kidnapper

$[U_G^w(n) = U_G^w(n,f) = U_G^w(n,b)]$

$U_G^w(n) > U_G^w(h,f) > U_G^w(h,b)$ against a killer

Furthermore, the weak government prefers hostages taken by the kidnapper to hostages taken by the killer.

$U_G^w(n) > U_G^w(h^{kid},b) > U_G^w(h^{kid},f) = U_G^w(h^{kil},f) > U_G^w(h^{kil},b)$

Where $U_G^w(h^i,b)$ denotes the payoff of the weak government from bargaining with type i terrorist after hostages have been seized, where i=kil,kid.

Note that if the government stays firm after hostages have been taken both types of terrorists kill the hostages. Therefore the utility of staying firm after hostages have been taken is equal, no matter which type of terrorist secured

the hostages: $U_G^w(h^{kil},f) = U_G^w(h^{kid},f)$. Therefore this utility will henceforth be denoted by $U_G^w(h,f)$.

If hostages have been seized and the government bargains, the kidnapper will release the hostages, but the killer will kill them anyway. Thus the government's payoffs of this outcome are different depending on which terrorist type took the hostages.

Note also that the government does not know the type of the terrorist before it chooses an action. Only expected payoffs can be derived ex ante. However, $U_G^w(x^i,y)$ denotes a payoff observed after the game is played.

The strong type prefers to stay firm against both types of terrorists.

$U_G^s(h^i,f) > U_G^s(h^i,b)$ i=kil,kid.

Furthermore, no matter which type of terrorist seizes hostages the payoff of staying firm is again the same.

$U_G^s(h^{kid},f) = U_G^s(h^{kid},f) > U_G^s(h^{kid},b) > U_G^s(h^{kil},b)$

Players have beliefs over the prior probability of the opponent's type. Denote the prior probability that the government is strong with α, that it is weak with 1-α and that the terrorist is a killer with β and that he is a kidnapper with 1-β.

Nax (2008) defines those probabilities as functions of preceding play. This presents the reputation-building variable in his model. Since the past is not observed in the one-shot game this probabilities are exogenously determined and their evolution over time is not properly modeled. Learning is an important component of the game, especially in consideration of reputation effects. Therefore, the probabilities and their changes during the play are crucial determinants of the optimality of strategies. While Nax's (2008) model presents a valuable analysis of the one-shot game which allows for comparative statics in the sense of interpretation of the outcomes depending on different exogenously given probabilities, reputation effects can not accurately be determined.

I chose to model reputation building by inclusion of a second period where the prior probabilities do not depend on the unobserved past, but change during the game according to the history of play. Therefore I do not allow for reputational effects in the

one period case. The multi-period analysis follows after the presentation of the equilibria of the one-shot game in the next section.

3.1.3. The perfect Bayesian Nash equilibria

The model yields at least two perfect Bayesian equilibria with pure strategies[3] and three alterations of those two where players are mixing their optimal pure strategies[4]. A perfect Bayesian Nash equilibrium takes the following form:

$PBNE = \{s_T; s_G\}$

The strategy of player j = {T,G} is denoted by s_j which describes an action for both of the player's possible types. Therefore, the strategy of the terrorist takes the following form $s_T = (x^{kil},x^{kid})$, where $x^i = \{h,n\}$ denotes the action taken by the terrorist type i = {kil,kid}. The strategy of the government $s_G = (y^w,y^s)$ where $y^k = \{b,f\}$ denotes the action taken by the government's type k = {weak, strong}.

Furthermore, the strategy combination can only form a perfect Bayesian equilibrium if players update beliefs during play. Therefore, certain restrictions on possible out-of-equilibrium beliefs might be necessary, if information sets are not reached by the equilibrium path. In the one-shot game only the government can update beliefs, because it moves second. The case of information sets off the equilibrium path only exists if the terrorist plays a pooling strategy, where both types take hostages. Then it has to be specified what the government would choose to do, given that no hostages would have been taken, because this information set is not reached by the equilibrium path. Denote the out-of-equilibrium belief by μ = Prob(kil | n) and $(1-\mu)$ = Prob(kid | n). Where μ denotes the probability that the terrorist is a killer conditioned on no hostages have been taken.

Before going into the specific equilibrium analysis it has to be stated that in an equilibrium of a one-shot game no player should play a dominated strategy. Therefore, the strong government and the killer terrorist have to play their dominant strategy, which is stay firm for the strong government and take hostages for the killer type terrorist.

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[3] There might be more pure strategy Bayesian equilibria, not satisfying more restrictive criteria (e.g. perfect Bayesian equilibrium).

[4] The alterations take the following form: Two equilibria exist where one player plays an optimal pure strategy and the other player mixes and one equilibrium where both players mix their optimal pure strategies. See Nax's paper for details.

Equilibrium 1:

Both types of government stay firm, the kidnapper terrorist doesn't take hostages and the killer does. PBNE = $\{(h^{kil}, n^{kid}); (f^w, f^s)\}$

The strong government and the killer terrorist play their dominant strategy. Neither the weak government nor the kidnapper type terrorist want to deviate, since the kidnapper prefers not to take hostages if the government stays firm (which it does no matter which type it is according to the strategy) and the weak government is indifferent between bargaining and staying firm if no hostages are being taken by the kidnapper and prefers to stay firm against a killer type. This is a separating equilibrium, due to the fact that no governmental information set is off the equilibrium path and therefore the government can update its beliefs over the terrorist's type before taking an action, implying that the government knows with certainty which type the terrorists is after observing the terrorist's action.

This is true for all prior probabilities over types and therefore for all possible values of α and β. Thus these strategies form a perfect Bayesian Nash equilibrium.

Equilibrium 2:

If $\alpha < \alpha^*$ and $\beta < \beta^*$ both types of terrorist choose to take hostages, the strong government stays firm and the weak government bargains.

PBNE = $\{(h^{kil}, h^{kid}); (b^w, f^s)\}$

Again the strong government and the killer terrorist play their dominant strategy. The weak government only wants to bargain if the probability that the terrorist is a killer is low enough and the kidnapper only wants to take hostages if the probability that the government is strong is low enough. Therefore, this is only an equilibrium if $\alpha < \alpha^*$ and $\beta < \beta^*$, where α^* and β^* are threshold values depending on the payoffs. Since this is a pooling equilibrium, out-of-equilibrium beliefs have to be determined. If no hostages would have been taken the strong government would still prefer to stay firm and the weak government would be indifferent, for all possible out-of-equilibrium beliefs over types of the terrorist. Therefore the proposed strategies form a perfect Bayesian Nash equilibrium for all possible $\mu \in [0,1]$.

The conditions on α and β:

For the proposed strategies to form an equilibrium the expected equilibrium payoff has to be higher than the expected payoff of the best possible deviation. $\pi_j^i(x)$

denotes the expected payoff of type i of player j from action x, given that the other player chooses its actions according to the equilibrium strategy.

The weak government will not deviate if its expected payoff of bargaining is higher than the expected payoff from staying firm:

$\pi_G^w(b) = \beta \times U_G^w(h^{kil},b) + (1-\beta) \times U_G^w(h^{kid},b) > U_G^w(h,f) = \pi_G^w(f)$

Therefore β has to be smaller than β^* for bargaining to be optimal for the weak government, where $\beta^* = \frac{U_G^w(h^{kid},b) - U_G^w(h,f)}{U_G^w(h^{kid},b) - U_G^w(h^{kil},b)} \in (0,1)$.

For the kidnapper terrorist to stick to the equilibrium strategy, his expected payoff from taking hostages has to be higher than the expected payoff of not taking hostages:

$\pi_T^{kid}(h) = \alpha \times U_T^{kid}(h,f) + (1-\alpha) \times U_T^{kid}(h,b) > U_T^{kid}(n) = \pi_T^{kid}(n)$

For this to hold α has to be smaller than $\alpha^* = \frac{U_T^{kid}(h,b) - U_T^{kid}(n)}{U_T^{kid}(h,b) - U_T^{kid}(h,f)} \in (0,1)$.

3.2. The two period game

To analyze possible reputation effects I extended the model to include a second period. Even though an infinite horizon would make the model even more realistic, the complicated structure of the game and its equilibria suggests to analyze learning and reputation effects more detailed in a once repeated game.

Learning is a crucial component of the repeated version of the game. Therefore, this has to be explained more detailed before analyzing possible equilibria. The government can learn already in the first period from the terrorist's action. Furthermore, after the first round players observe their payoffs received from that period. This is a decisive element of the game especially concerning the government, which learns not only from the terrorist's action, but also from the payoffs received. If hostages have been taken and the government bargained it knows with certainty with which type of terrorist it is confronted with, due to the fact that the kidnapper releases the hostages if bargaining took place and the killer nevertheless kills them. Thus,

learning does not only occur due to actions but also due to observed payoffs. The terrorist learns only from the action taken by the government in the first period.

There are multiple possibilities for pure strategy equilibria in the repeated version of the model. Therefore I concentrate on the changes that the repetition induces and analyze if reputation building can be sustained in equilibrium. Due to repetition it might be optimal for players to choose actions which were not part of the equilibrium outcomes in the one period game. Actions that are excluded from optimal play (non-equilibrium actions) in the first period are bargaining for the strong government and not taking hostages for the killer.
Bargaining by either type of government signals to the terrorist that the government is weak. This is not optimal for the strong government since it encourages hostage-taking. Therefore bargaining by the strong government will also not be an optimal action in an equilibrium of the two shot game. By not taking hostages in the first period the terrorist might signal to the government that he is a kidnapper (since it is a dominated strategy in the one-shot game for the killer). The killer could use this to imitate a kidnapper, or in other words to build up a reputation as a kidnapper. This can only be optimal for a killer type terrorist if he expects the government to bargain with a kidnapper.

<u>Therefore the main questions of interest are:</u>

1. Are the two one-shot equilibria still equilibria of the repeated version?
2. Can an equilibrium be constructed where the killer chooses not to take hostages in the first period, thereby imitating a kidnapper type (to achieve bargaining)?
3. Will the weak government always want to build up a reputation to be strong to deter hostage-taking? Or asked differently, is choosing to bargain in the first period still an optimal action and will it therefore be part of an equilibrium path?

3.2.1. Are the two one-shot equilibria still equilibira of the repeated version?

Before analyzing the two one-shot equilibria in a repeated setting, a crucial feature of the repeated interaction has to be emphasized. Learning can happen through two channels. First, observed actions taken according to the equilibrium strategy can signal which type the opponent is, if he plays a separating strategy. If the opponent plays a pooling strategy, however, actions are no indicator for types. The payoffs, on the other hand, which are observed after every round, can support identification of types.

Equilibrium 1:

Only the killer type terrorist takes hostages and both types of the government stay firm in both periods: $\{(h^{kil}, n^{kid});(f^{w}, f^{s})\}$

The terrorist does not learn the government's type since the government chooses a pooling strategy. The government on the other hand knows after the first move of the terrorist which type he is confronted with, since the terrorist plays a separating strategy.

The killer type terrorist and the strong government type play their dominant one-shot strategy and therefore do not want to deviate. The kidnapper terrorist does not want to take hostages in any period if both government types do not bargain.

If hostages are being taken the weak government will not want to bargain, because it knows that only the killer takes hostages and is indifferent between bargaining and staying firm if no hostages are being taken, therefore it will not deviate.

Thus this is still a Bayes Nash equilibrium in the repeated version of the model.

In a perfect Bayesian Nash equilibrium of a repeated game the actions taken at off equilibrium path decision nodes need to be optimal as well, meaning that actions have to be optimal for all possible histories of the game and have to be such that incentives to stick to the equilibrium strategies are satisfied.

There are no decision nodes off the equilibrium path for the government, since already in period one it knows the terrorist's type due to the terrorist's separating strategy. For all possible histories of the game the killer terrorist will optimally take hostages. However, the kidnapper has two decision nodes for which optimal actions

need to be determined in the equilibrium strategy. If the kidnapper takes hostages in the first period and the government bargains, he still does not want to take hostages in the second period because staying firm is the proposed equilibrium strategy for both types of government. Following the same rational this holds for the government staying firm in period one after hostages have been taken as well. This is true for all possible beliefs over types.

Therefore the strategies in the perfect Bayesian Nash equilibrium are: *both types of government stay firm, the killer takes hostages and the kidnapper does not, in both periods and for all possible histories of the game.*

PBNE = $\{(h^{kil}, n^{kid})_p^t; (f^w, f^s)_p^t; t = 1,2; p \in P\}$

(Note that the structure of the equilibrium changed slightly to include actions for both periods. t =1,2 refers to period one and two and P is the set of all possible past actions played in the game, or in other words the history of play.)

Equilibrium 2:

If $\alpha < \hat{\alpha}$ *and* $\beta < \hat{\beta}$ *the terrorist takes hostages in both periods no matter which type he is and the government bargains if it is weak and stays firm if it is strong in both periods:* $\{(h^{kil}, h^{kid})_p^t; (b^w, f^s)_p^t; t = 1,2; p \in P\}$

Since this would be a pooling equilibrium, the government does not learn about the terrorist's type from his actions. However, the weak government learns after the first period which type the terrorist is, due to the fact that it bargains and the kidnapper releases the hostages and the killer kills them. The learning takes place via the observed payoffs, which are different for hostage-taking and bargaining with a killer and a kidnapper. Furthermore, the terrorist learns which type the government is after the first period, due to the government's separating strategy.

As stated before, staying firm is still a dominant strategy for the strong government, implying that it will not want to deviate. Since the weak government learns what type the terrorist is, the probability that the terrorist is a killer (β) will be either 0 or 1. If hostages are being taken in the second period the government will only want to bargain with the kidnapper type. Therefore the optimal strategy for the weak government cannot be to bargain in both periods for all possible histories, but the

only optimal response to the strategy of the terrorist is to bargain in the second period if and only if the terrorist is a kidnapper and stay firm otherwise.

Note that bargaining after hostage-taking in the first period by the government implies an advantage for the government, because it learns about the terrorist's type after observing the payoffs of the first round. Those payoffs are different for bargaining with a killer and with a kidnapper. This advantage however will not change optimal play. The strong government will not want to bargain in any round, since bargaining is dominated. The weak government will only want to bargain for certain prior beliefs over types (β). Therefore, bargaining in the first period just to ascertain the type of terrorist will not be optimal.

Since the weak government learns what type the terrorist is after the first period, the equilibrium of the stage game is not an equilibrium of the repeated version. But the question that arises at this point is, if an equilibrium can be attained with the slight alteration of the strategy of the weak government suggested above.

The proposed equilibrium strategies are:
If $\alpha < \hat{\alpha}$ *and* $\beta < \hat{\beta}$ *both types of terrorist take hostages in both periods. The strong government stays firm in both periods and the weak government bargains in the first period and bargains again in the second period if the terrorist reveals himself to be a kidnapper and stays firm in the second period if the terrorist is a killer:*
$\{[(h^{kil}, h^{kid})_p^t; t = 1,2]; [(b^w, f^s)_p^{t=1}, (b^w|kid, f^w|kil, f^s)_p^{t=2}]; p \in P\}$
(where $b^w|kid$ *denotes bargaining by the weak government conditional on the terrorist being a kidnapper and* $f^w|kil$ *denotes staying firm by the weak government if the terrorist is a killer)*

The strong government plays its dominant strategy. The weak government wants to bargain in the first period if $\beta < \hat{\beta}$ and chooses the optimal action in period two after having learned the type of the terrorist.
The killer terrorist will want to take hostages in all periods, since there is bargaining in period one with probability $1-\alpha$ and in period two with probability zero and cannot be better off else. The kidnapper also takes hostages and gets bargaining in the first period with probability $1-\alpha$, which is only optimal for certain values of α. In the second

period, however, he knows what type the government is and will only want to take hostages if the government is weak. Therefore those strategies are not optimal as well.

An equilibrium can be constructed with the alterations of the proposed strategies as follows:

The killer takes hostages and the strong government stays firm in both periods. The weak government bargains in the first period if $\beta < \hat{\beta}$ *and bargains again in the second period if the terrorist reveals himself to be a kidnapper and stays firm if the terrorist is a killer. The kidnapper takes hostages in period one if* $\alpha < \hat{\alpha}$ *and again in the second period if there was bargaining in the first and not otherwise:*

$\{[(h^{kil}, h^{kid})^{t=1}; (h^{kil}, h^{kid}|b^{t=1}, n^{kid}|f^{t=1})^{t=2}]; [(b^{w}, f^{s})^{t=1}; (b^{w}|kid, f^{w}|kil, f^{s})^{t=2}]\}$

After the first period the terrorist knows which type the government is and the weak government learns what type the terrorist is. The killer and the strong government play their optimal strategies. The kidnapper gives an optimal response to the strategy of the government. But the weak government, which gives an optimal response in the second period, could have an incentive to imitate the strong government by staying firm in the first period to deter the kidnapper from taking hostages in the second period. Depending on the parameters of the model this strategy combination can be sustained in a perfect Bayesian Nash equilibrium.

<u>Conditions on α, β and the payoffs:</u>

Expected payoff of the proposed equilibrium strategy (s_G^*) for the weak government has to be higher than the expected payoff of the best deviation, which is deterring hostage-taking in the second period by staying firm in the first[5].

$$\pi_G^w(s_G^*) = \beta \times U_G^w(h^{kil},b) + (1-\beta) \times U_G^w(h^{kid},b) + \beta \times U_G^w(h,f) + (1-\beta) \times U_G^w(h^{kid},b) > U_G^w(h,f) + \beta \times U_G^w(h,f) + (1-\beta) \times U_G^w(n) = \pi_G^w(f^{t=1}, f^{t=2})$$

The expected payoff of the proposed equilibrium strategy (s_T^*) for the kidnapper has to be higher than the expected payoff of not taking hostages in both periods.

[5] Note that due to simplification no discounting is used.

$\pi_T^{kid}(s_T^*) = \alpha \times U_T^{kid}(h,f) + (1-\alpha) \times U_T^{kid}(h,b) + \alpha \times U_T^{kid}(n) + (1-\alpha) \times U_T^{kid}(h,b) > 2 \times U_T^{kid}(n) = \pi_T^{kid}(n^{t=1}, n^{t=2})$

Thus the perfect Bayesian Nash Equilibrium takes the following form:

PBNE = {[(h^{kil}, h^{kid})$^{t=1}$; (h^{kil}, h^{kid}|$b^{t=1}$, n^{kid}|$f^{t=1}$)$^{t=2}$]; [(b^w, f^s)$^{t=1}$, (b^w|kid, f^w|kil, f^s)$^{t=2}$]}

If $\alpha < \hat{\alpha}$ *and* $\beta < \hat{\beta}$.

Where $\hat{\beta} = \dfrac{2 \times U_G^w(h^{kid},b) - U_G^w(n) - U_G^w(h,f)}{2 \times U_G^w(h^{kid},b) - U_G^w(n) - U_G^w(h^{kil},b)}$ (< 1)

and $\hat{\alpha} = \dfrac{2 \times U_T^{kid}(h,b) - 2 \times U_T^{kid}(n)}{2 \times U_T^{kid}(h,b) - U_T^{kid}(h,f) - U_T^{kid}(n)}$ $\in (0,1)$[6].

Since β takes only values between zero and one, this can only hold if $2 \times U_G^w(h^{kid},b) > U_G^w(n) + U_G^w(h,f)$.

The payoff the weak government receives from twice hostage-taking and bargaining with the kidnapper has to be higher than once hostage-taking and staying firm and once no hostage-taking.

Note that, the terrorist again plays a pooling strategy, therefore out-of-equilibrium beliefs have to be determined. If no hostages would have been taken in the first period the weak government would be indifferent between staying firm and bargaining. Therefore, no matter what type the terrorist the government believes to be confronted with, it does not want to deviate from the equilibrium strategy. Thus, the proposed strategies form a perfect Bayesian Nash equilibrium for all possible out-of-equilibrium beliefs $\mu \in [0,1]$.

The analysis in this section established that equilibrium 1 is also an equilibrium in the two period version of the game. As shown above, equilibrium 2 is more difficult to sustain in the repeated model. Changes of the strategies and stronger restrictions for β are needed in the two period case. Furthermore, this restriction can only hold for certain relative payoff values.

[6] Note that $\alpha^* < \hat{\alpha}$ and β and $\hat{\beta}$ are not comparable without knowing the exact values or relations of the payoffs.

3.2.2. Does a killer want to build up a reputation of being a kidnapper?

First it has to be noted that the killer will take hostages in the second period, because the game ends there and hostage-taking is his dominant strategy. Furthermore, he will only choose to build up a reputation as kidnapper if he believes that it is likely that the government is weak. Therefore his strategy will be, not to take hostages in period one and take hostages in period two for all possible histories. The terrorist has to play a pooling strategy (i.e. both types choose the same strategy) otherwise the government would know if the terrorist is a killer.

The optimal response to this strategy of the terrorist for the government is always staying firm for the strong type and stay firm in period one and bargain in period two for the weak type if $\beta < \beta^*$[7], since he is indifferent between staying firm and bargaining in the first period and prefers to bargain in the second period if he believes the probability that the terrorist is a kidnapper to be high enough.

The proposed equilibrium strategies are:
Both types of terrorist do not take hostages in the first period and take hostages in the second and the strong government stays firm in both periods, for all possible histories. The weak government stays firm in the first period and bargains in the second if and only if $\beta < \beta^*$ and no hostages are being taken in the first period. Otherwise it also stays firm in both periods:
$\{[(n^{kil}, n^{kid})^{t=1}, (h^{kil}, h^{kid})^{t=2}]; [(f^w, f^s)^{t=1}, (b^w|n^{t=1}, f^w|h^{t=1}, f^s)^{t=2}]\}$

Staying firm in both periods for all possible histories is again an optimal strategy for the strong government. Since both types of terrorists choose the same strategy (pooling) the government learns nothing about the terrorist's type. Therefore bargaining in period two is optimal for the weak government only if $\beta < \beta^*$ and staying firm is optimal in period one since it is indifferent if no hostages are being taken. As stated above, for a perfect Bayesian Nash equilibrium it is required that optimal decisions are also being taken at off equilibrium path decision nodes. Therefore it

[7] Here β^* is again the same as in the one period analysis, because only one period prevails when hostages are being taken in period two: $\beta^* = \frac{U_G^w(h^{kid},b) - U_G^w(h,f)}{U_G^w(h^{kid},b) - U_G^w(h^{kil},b)}$

has to be defined what the weak government would do if hostages were taken in the first period. Since the strategy for both types of government states to stay firm in the first period the only terrorist type which could benefit from taking hostages is the killer, since the kidnapper is better off if he does not take hostages if the government stays firm. Hostages being taken in the first period therefore is an indicator for the government that the terrorist is a killer. The optimal response would be to stay firm in both periods. Thus, the proposed strategy is optimal for the government.

The kidnapper does not want to deviate, because taking hostages in the first period does not yield bargaining and taking hostages in the second period is optimal if $\alpha < \alpha^*$, since there is bargaining in the second with probability 1-α. Therefore the proposed equilibrium strategy is optimal for the kidnapper only if $\alpha < \alpha^*$, otherwise he would choose not to take hostages in both periods[8]. Given the strategy of the government, the killer wants to take hostages in the second period and does not want to take hostages in the first period only for certain values of α. The expected payoff of not taking hostages in the first period and taking hostages in the second, has to be higher than the expected payoff of taking hostages in both periods:

$\pi_T^{kil}(n^{t=1}, h^{t=2}) = U_T^{kil}(n) + \alpha \times U_T^{kil}(h,f) + (1-\alpha) \times U_T^{kil}(h,b) > 2 \times U_T^{kil}(h,f) = \pi_T^{kil}(h^{t=1}, h^{t=2})$

Deviation is not profitable for $\alpha < \alpha^{**} = \frac{U_T^{kil}(n) + U_T^{kil}(h,b) - 2 \times U_T^{kil}(h,f)}{U_T^{kil}(h,b) - U_T^{kil}(h,f)}$ (< 1).

Therefore a perfect Bayesian Nash equilibrium can be sustained where the killer imitates a kidnapper:

PBNE = $\{[(n^{kil}, n^{kid})^{t=1}, (h^{kil}, h^{kid}|n^{t=1}, n^{kid}|h^{t=1})^{t=2}]; [(f^w, f^s)^{t=1}, (b^w|n^{t=1}, f^w|h^{t=1}, f^s)^{t=2}]\}$

If $\alpha < \alpha^*, \alpha < \alpha^{**}, \beta < \beta^*$.[9]

If no hostages have been seized in period one, the weak government bargains and the strong government stays firm. If however, hostages have been taken in the first period, the weak government also stays firm in the second period, because only the killer type terrorists benefits from hostage taking in the first period. If the kidnapper took hostages in period one (even though he prefers not to, since there is no bargaining), he will not take hostages in period two as well, because both types of

[8] Note that due to the fact that he will only take hostages in period two, which is the last period, α^* takes again the same value as before: $\alpha^* = \frac{U_T^{kid}(h,b) - U_T^{kid}(n)}{U_T^{kid}(h,b) - U_T^{kid}(h,f)}$

[9] Note that, without knowing the exact payoff values or relations no statement can be made about which α^* or α^{**} takes a higher value.

government stay firm. (This aspect of the equilibrium is necessary for it to be a perfect Bayesian Nash equilibrium.)

Since α cannot be smaller than zero, this can only hold for $U_T^{kil}(n) + U_T^{kil}(h,b) > 2\times U_T^{kil}(h,f)$. This equilibrium therefore again depends on the payoffs.

There are two noteworthy aspects of this equilibrium. First, the killer can only imitate the kidnapper for one period. After imitating the kidnapper the equilibrium outcome for the next period is hostage-taking and staying firm. Since the killer kills the hostages even if bargaining takes place the government knows that it faces a killer. This is only relevant if more than two periods would be considered. Second, since the terrorist chooses a pooling strategy, the government does not learn about the terrorist's type. Although not taking hostages is dominated for the killer, it is stated as his strategy, therefore no hostages taken is no indicator for the terrorist being a kidnapper. Thus the probability for bargaining stays the same and there is a priori no incentive to imitate the kidnapper. But, if the government's strategy is as stated, the killer type gives a best response.

3.2.3. Is choosing to bargain in the first period still an optimal action?

The government will not always want to build up a reputation to be strong to deter hostage-taking. As shown above, there can be an equilibrium of the two period game, where bargaining takes place. This equilibrium, which is an alteration of the one-shot equilibrium 2, however not only depends on the probabilities α and β, but also on the payoffs. Even though this implies that no precise answer can be given to the question if bargaining should occur in an equilibrium, a general statement can be made that bargaining may occur under certain circumstances depending on the beliefs of the players and the values of the payoffs. However, as shown in the discussion around equilibrium 1 staying firm is easier to sustain in an equilibrium, since it is not just an equilibrium of the repeated game as well, but it furthermore does not require restrictions over beliefs.

4. Results and conclusions

The game theoretic approach of the present analysis of reputation building by governments and terrorists in hostage-taking incidents provides several advantages to model the strategic interactions between governments and terroristic groups. Even though the theoretic models are largely not advanced enough yet to provide policy recommendations, which in my opinion should be the ultimate goal of this research, the present analysis of hostage-taking events and how reputation considerations change the behavior of the affected agents yields several important new insights into the issue of hostage-taking and reputation effects. Those are especially relevant, since this thesis is to my knowledge the first game theoretic approach to model explicit reputation effects in a two period imperfect information model of hostage-taking, where terrorists as well as governments can be of different types.

The main findings of the model include that building up a non-negotiation reputation could indeed be optimal for governments. However, this is not the only optimal strategy prevailing. Under certain restrictions it can also be optimal to negotiate with terrorists. This depends largely on the payoffs of each outcome and the prior beliefs. Generally speaking it can be stated that the probability that the government bargains and the probability that the government faces a moderate terrorist have to be high enough, for this outcome to emerge.

More specifically, I find that different to Nax's prediction only one of the equilibria from the one-shot game can be sustained in the repeated version, namely equilibrium 1 where both types of government choose to stay strong in both periods and only the killer type terrorist will take hostages. This strategy of the government excludes bargaining. Therefore I find theoretical evidence that a non-negotiation policy can be optimal. The second one-shot equilibrium can only be sustained as an equilibrium of the repeated interaction game after multiple alterations and for certain values for the beliefs and the payoffs. This equilibrium includes bargaining by the government. Therefore bargaining does not become a dominated strategy in the two period model. Rigorous restrictions on payoffs are needed, however, including that the prior probabilities that the government is strong and that the terrorist is a killer are low enough.

Furthermore I find that extremely radical terroristic groups can find it optimal to imitate moderates in order to mislead the government to negotiate. However, imitating a kidnapper can only be optimal for the killer type for certain restrictions on payoffs and beliefs. Again, the probabilities that the government is strong and that the terrorists is a killer have to be low enough. Furthermore, payoffs from imitating a kidnapper once and taking hostages and bargaining once have to be higher than always taking hostages.

Generally, the research on hostage-taking is mostly not advanced enough yet to draw policy implications. I do not argue that my model is an exception. However, it provides new insights in the theory of hostage-taking and paves the way for further research in this area. The model could be extended to study reputation effects even more thoroughly. Possible extensions of the model include larger numbers of players, types and periods. Either more terroristic organizations or multiple governments could be introduced in the game. The inclusion of intermediate types with certain probability distributions would make the model even more realistic. An infinite horizon especially would provide more validity to the model. In the model section I present one implication for a multiple period version, namely that the killer can only imitate the kidnapper once. Further conclusions on the more than twice repeated game cannot be drawn at this point.

The novelty of the game presented in this thesis is the thorough analysis of the repeated interaction of governments and terrorists in hostage-taking incidents. The equilibria analysis provides theoretical proof for the importance of reputation effects. This is true for the government as well as the terrorist. Hardliner terrorists can find it optimal to build up a reputation of being moderates. Furthermore, it is optimal for weak governments to play a non-negotiation strategy to build up a reputation to be strong, for certain strategies of the terrorist. To a certain extent this provides validity to non-negotiation policies of governments.

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6. Appendix

6.1. Abstract (German)

Die vorliegende Abhandlung setzt sich aus einer spieltheoretischen Perspektive mit dem Thema Geiselnahmen als wichtigem Teilaspekt von Terrorismus auseinander. Bisherige Studien zur Thematik aus unterschiedlichen disziplinären Perspektiven ließen zumeist ökonomische Aspekte außer Acht. Die Spieltheorie, als ökonomisches Werkzeug, ermöglicht neue Einblicke in das kontroversielle Thema, da sie die für Geiselnahmen typischen strategischen Interaktionen zwischen Regierungen und terroristischen Organisationen zu analysieren vermag. Unter anderem wurden Fragen wie die Rationalität von Terroristen, die Optimalität anti-terroristischer Strategien und Faktoren, die den Erfolg von Geiselnahmen beeinflussen, in bisherigen spieltheoretischen Analysen aufgegriffen.

Das in dieser Arbeit präsentierte Modell fügt den bisherigen Studien als neuen Aspekt die genaue Analyse der Reputationseffekte in der wiederholten Interaktion von Regierungen und Terroristen, die sich in der Situation einer Geiselnahme befinden, hinzu. Obwohl die Resultate des Modells nahelegen, dass Strategien einer Ablehnung von Verhandlungen mit Terroristen wahrscheinlicher auftreten als solche, die auf ein Einlenken abzielen, um eine entsprechende Reputation aufzubauen, kann keine klare Aussage darüber getroffen werden, welche Strategie von Regierungen zu bevorzugen ist. Auf der Grundlage des bisherigen Forschungsstandes können daher noch keine eindeutigen politischen Empfehlungen geben werden. Weiters bietet das Modell theoretische Beweise für die mögliche Optimalität einer Imitationsstrategie für Hardliner-Terroristen, die vorsieht, moderate terroristische Organisationen zu imitieren, um damit von Reputationseffekten zu profitieren, indem die Regierung zu Verhandlungen bewegt wird. Insgesamt erbringt die Gleichgewichtsanalyse den theoretischen Beweis für die Bedeutung von Reputationseffekten für beide in Geiselnahmen involvierte Parteien.

6.2. Abstract (English)

This thesis analyses hostage-taking scenarios, as an important aspect of terrorism, from the point of view of game theory. Different research areas have studied terrorism, but these analyses usually exclude economic aspects. Game theory as an economic tool can provide new insights into this controversial topic by analyzing the existing strategic interactions between governments and terroristic organizations. Game theoretic approaches to terrorism have investigated questions about the rationality of terrorists, optimality of counter-terroristic strategies and factors influencing the success of hostage-taking among others.

The novelty of the model presented in this thesis is its thorough analysis of reputation effects in the repeated interaction of governments and terrorists in hostage-taking incidents. While the results suggest that non-negotiation policies of governments are more likely to be optimal in a multi-period setting than is concession to terrorists' demands, due to the status of the research in this area, no clear answer can be given as to which strategy should be preferred. Furthermore, the model suggests that radical terrorist groups can find it beneficial to imitate moderates to benefit from reputation effects by misleading the government to negotiate. Concluding, it can be stated that the equilibria analysis provides theoretical proof for the importance of reputation effects.

6.3. Curriculum Vitae

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