Anti-Terrorism, Surveillance, and Executive Power[1]

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Abstract

In this paper, I address the question of whether increasing the government's surveillance powers enhances help preventing a terrorist attack. I show that increasing surveillance powers does not necessarily enhance security even if we abstract way from the civil liberties losses and only consider the effect of surveillance powers on enhancing security. I develop a formal model in which the probability of a terrorist attack is endogenous to the decisions of the government and the terrorist organization. I show that, under certain conditions, the probability of a terrorist attack increases when relaxing restrictions on surveillance powers. In addition, I show that an agency problem exists: the optimal security-enhancing surveillance policy is different than the government's most preferred surveillance policy if the probability of a terrorist attack does not decreases with more restrictions on surveillance. These findings contribute to the current policy and scholarly debates regarding the expansion of the government's surveillance powers at the expense of privacy rights in the context of fighting terrorism.

1 Introduction

Does increasing the government's surveillance powers help prevent a terrorist attack? The 9/11 terrorist attacks placed counterterrorism at the top of the national policy agenda in many Western democracies. Faced with the prospect of suicide terrorism against which little can be done in term of criminal prosecution, liberal-democratic states have introduced various policies with the objective of foilling terrorist attacks before they are executed. Key among such preventive measures is the government's ability to access and collect information in order to identify and monitor potential terrorists. However, the government's surveillance powers collided with various legal restrictions on the government's actions vis-a-vis individual privacy.

After 9/11, liberal democratic states have relaxed or eliminated various restrictions on the government's surveillance powers. Six weeks after 9/11, Congress passed the Patriot Act, France passed surveillance legislation on October 31, 2001, United Kingdom on December 13, 2001, and Germany on December 20, 2001. All these surveillance laws extended the breadth and penetration of surveillance powers at the expense of privacy rights. They have established new monitoring patterns for financial transactions; they have introduced or extended retention of telephone and electronic communication; they have eased legal restrictions on monitoring individuals identified as potential terrorists.

The increase in the government's surveillance powers has produced a lively public and scholarly debate about the trade-off between security and civil liberties: On the one hand, increasing surveillance powers negatively impacts civil liberties but, on the other hand, increasing surveillance powers enhances security by helping to prevent terrorist attacks. In this paper, I argue that the trade-off is more complex than the one discussed in the existing literature. I will show that even if we abstract away from civil liberties losses, it is possible that more surveillance powers diminish security. The existing literature takes for granted the fact that increasing surveillance powers enhances security although we lack an understanding

of the mechanism of how more surveillance powers translate into more security.

In this paper, I develop a formal model that will allow us to compare the probability of a terrorist attack in a world with more surveillance powers vis-a-vis a world with less surveillance powers. In the model, the level of restrictions on surveillance powers affects both the government's and the terrorist's decisions while the probability of a terrorist attack is endogenous to the decision of the government and the terrorist. The government decides how much effort to put into preventive investigation of a suspected terrorist and the terrorist decides whether to plan a terrorist attack or not. If the terrorist plans an attack, the probability of a successful terrorist attack decreases if the government exerts more preventive investigation effort. The level of restrictions on surveillance powers affects both the government's capacity for exerting preventive investigation effort and the terrorist's capacity to plan an attack. First, more restrictions on surveillance powers increase the government's cost for exerting preventive investigation. Second, more restrictions on surveillance powers (and implicitly more privacy) decrease the terrorist's cost for planning an attack.

Given these assumptions, I present two main findings. First, I show that increasing the government's surveillance powers does not necessarily enhance security. Relaxing restrictions on surveillance powers has a direct and an indirect (strategic) effect on both the government and the terrorist's decisions. The strategic effect exists because restrictions on surveillance affect both the terrorist and the government's payoffs and as a result each party takes into account the effect of restrictions on surveillance powers on the other party's payoff. For the terrorist, the direct and the indirect effects work in the same direction and induce the terrorist to be less likely to plan an attack when we increase the government's surveillance powers. For the government, the two effects work in an offsetting direction because the government anticipate that more surveillance powers increases the terrorist's cost for planning an attack. Because of this strategic effect, it is possible to increase the probability of a terrorist attack when we increase the government's surveillance powers.

Second, I show that the security-enhancing surveillance policy is not necessarily the

same as the government's most preferred level of restrictions on surveillance powers. If the probability of a terrorist attack increases with more restrictions on surveillance powers, an agency problem emerges. In addition to minimizing the probability of a terrorist attack, the government also wants to minimize its preventive investigation cost. Since the government's cost is decreasing with more surveillance powers, the government prefers a lower level of restrictions on surveillance powers than the level that minimizes the probability of a terrorist attack.

I proceed as follows. First, I discuss the existing literature and the contributions on this paper. Second, I discuss informally the assumptions and the results of the game-theoretic model. Third, I set up and solve the model. Fourth, I point out the policy implications of the analysis. Finally, I conclude and discuss future research.

2 Extant Literature

The paper contributes to the political theory literature on security versus liberty and to the political economy literature on terrorism. Legal and political philosophers have debated extensively on the effectiveness of antiterrorism legislation. The existing scholarship on the antiterrorism legislation invites us to think about this in term of the idea of a balance. In this view, most civil liberties and rights are not absolute but must be balanced against security. If security becomes more important, we must expand the power of the government. Fewer legal restrictions on government action enhance security and this is the appropriate policy because the September 11 terrorist attack has shifted the balance in the direction of more security (Posner and Vermule 2005; Posner 2006; Posner and Vermule 2007).

Other scholars have come on the civil liberties side of the balance to argue that the antiterrorism policy is a bad policy because the government decision-making is bad during times of emergencies (Ackerman 2006; Stone 2004; Cole and Dempsey 2002), because the long-term ratchet effect of expanding governmental power (Stone 2004; Gross and Aolain

2006), or because antiterrorism policies are more likely to affect minorities (Waldron 2003; Cole 2003).

The existing literature has yet to analyze the premise that increasing surveillance powers enhances security, a premise on which all the arguments in favor of antiterrorism surveillance legislation rest and a premise that has not been challenged even by works that defend the civil liberties side of the balance. The previous works take as a black box the process of how more surveillance powers increase security. I explicitly study such a process and show that increasing surveillance powers does not necessarily increase security even if security is the only objective. I will only look at the security-side of the balance not because I think the right to privacy has no intrinsic value but because I want to show that the trade-off of increasing surveillance powers is more complex that the one analyzed in the security versus civil liberties debate.

The paper also contributes to the political economy literature on terrorism. A small political economy literature on terrorism and counterterrorism back over two decades, but this literature has exploded since 9/11 terrorist attack. It addresses several critical questions about terrorism, including the structural determinants of terrorism (Pape 2003; Li 2005; Abadie 2006; Blomberg, Hess, and Weerapan 2004; Enders and Sandler 2006), the optimal (or suboptimal) counterterrorism policy (Bueno de Mesquita 2005, Enders and Sandler 1993; Rosendorff and Sandler 2004; Bueno de Mesquita 2007; Powell 2007a; Powell 2007b), terrorism and radical mobilization (Bueno de Mesquita and Dickson 2007), and the internal politics of terrorist organizations (Chai 1993).

The political economy literature has yet to analyze how legal restrictions on government action impact the effectiveness of counterterrorism policy. This topic is important given that the liberal democratic state has to fight terrorism while respecting the rule of law and civil liberties. I develop a game-theoretic model to analyze the legal aspects of counterterrorism policy in the context of surveillance legislation. I study formally how legal restrictions on surveillance impact the incentives of both the government and the terrorists and show that

relaxing restrictions on surveillance powers is the suboptimal (security-enhancing) counterterrorism policy under certain conditions.

The analysis in this paper is more related to Powell (2007a) and Bueno de Mesquita (2007). Powell analyzes the optimal allocation of resources to different potential targets of terrorism. In Powell's model, a defender has to decide how to allocate its resources across an arbitrarily large number of sites and the attacker has to choose which site to strike. Powell offers an analysis of optimal protection countertrerrorism policy. Generally, we can distinguish between two counterterrorism strategies: prevention and protection. Protection is target specific; it refers to hardening various potential terrorist targets. Prevention is individual specific; it refers to collecting and analyzing information about potential terrorist to detect a terrorist plot before it occurs. My model analyzes the relationship between restrictions on surveillance powers and the optimal prevention counterterrorism policy.

Bueno de Mesquita develops a model of interactions between voters, a government, and a suspected terrorist (Bueno de Mesquita 2007). He analyzes the optimal counterterrorism policy given that counterterrorism allocations can be divided between observable and unobservable tactics. In Bueno de Mesquita's model, agency problems between the voters and government create a situation in which the counterterrorism strategy pursued by the government in response to electoral and institutional incentives is different from the security maximizing counterterrorism strategy. In this paper, I restrict my analysis to surveillance powers (an unobservable counterterrorist tactic) to analyze how restrictions on surveillance powers affects the probability of a terrorist attack.

3 Surveillance, Privacy, and Security

In this paper, I define the right to privacy as restrictions on the government's surveillance powers. The right to privacy is difficult to define. Philosophers have written extensively on this topic and they still debate whether privacy is a fundamental right or whether it is a right

derived from other fundamental rights (Thomson 1975; Scalon 1975; Reiman 1975; Schoeman 1984). Also, lawyers have written and debated extensively what should be legal boundaries of individual privacy. These philosophical and legal definitions are more inclusive than my definition, however, they include other aspects of privacy that do not affect my analysis.

My objective is to compare the probability of a terrorist attack in a world with more privacy/more restrictions on surveillance powers vis-as-vis a world with less privacy/less restrictions on surveillance powers. For a terrorist attack to occur it must be the case that the terrorist plans an attack while the government fails to identify and stop the attack at the planning stage. In other words, the probability of a terrorist attack is endogenous to the decisions of the government and the terrorist and it depends on how likely is the terrorist to plan an attack and how likely is the government to prevent the attack by putting effort into investigating the suspected terrorist and preventing the attack should the terrorist plan an attack.

Preventing a terrorist attack at the planning stage presents two challenges for the government. The first challenge is that the government does not know before investigating whether suspected terrorists is an actual terrorist. Terrorism prevention is essentially a fishing strategy, not all suspected terrorists are actual terrorists that want to execute an attack if the circumstances are favorable. From the government's perspective the suspected terrorist is either an innocent individual or a terrorist. Before making the decision to investigate the suspected terrorist, the government does not know with certainty her type. The government has to allocate personnel and resources to collect information and monitor the whereabouts of the suspected terrorist in order to determine if the suspected terrorist plans an attack or not.

The second difficulty is that government does not observe the terrorist's decision to organize and plan a attack. An important advantage of terrorists is their flexibility in organizing and planning attacks; terrorists can lay low and not do nothing suspect which makes it difficult for the government to separate terrorists from an innocent individuals.

In other words, even if the suspected individual is an actual terrorist, the terrorist could strategically decide to do nothing and pool with the innocent individual. This makes it harder for the government to investigate the terrorist because the government could learn the terrorist type only if the terrorist plans an attack and separate himself from innocent individuals.

Regardless of these difficulties, the government can reduce the probability of a successful terrorist attack by putting more effort into investigating the suspected terrorist. The preventive investigation effort amounts to allocating resources for monitoring the suspected terrorist, for gathering analyzing information about his whereabouts, all these to figure out the suspected individual's plans. However, the preventive investigation is costly and more resources the government allocates to preventive investigation higher the cost. First, there is an opportunity cost in relation to other suspected terrorists. Terrorism is not a static but a dynamic phenomenon: the pool of potential terrorists is not fixed but changes with the circumstances. The amount of preventive investigation effort the government allocates to monitor a suspected terrorist implies that the government cannot allocate those resource to investigate other potential suspected terrorists. Second, there is an opportunity cost in relation to other crimes and activities that the government could spend resources on. Terrorism is not the only crime, if resources are spend on preventive investigation of suspected terrorists, the same resources cannot be spend on investigating other crimes such as drug traffic, white collar crime, fraud, etc.

The level of restrictions on surveillance powers affect the government's cost for preventive investigation. Key to the preventive investigation strategy is the government's ability to intrude into the suspected terrorist's privacy in order to collect and analyze information and monitor her behavior. However, if there are more restrictions on the government's access to electronic and telephone communication, to gathering information from third parties, to data retention and secret searches, such restrictions make it harder for the government to investigate and monitor suspected terrorists. Essentially, fewer restrictions on surveillance

powers decreases the government's cost for preventive investigations.

Now, on the terrorist's side of the equation, the terrorist decide whether to plan an attack or not. If the terrorist does not plan an attack and essentially pools with innocent individuals the probability of a terrorist attack is zero. Only when the potential terrorist plans an attack, the probability of a terrorist attack is positive and varies with how much effort the government allocates to preventive investigation. Planning and organizing a terrorist attack is costly for the terrorist. The level of privacy protections, the flip side of the level of restrictions on surveillance powers, affects the terrorist's costs for planning and organizing an attack. Protecting privacy by restricting the government access to the citizens' private space provides a fertile ground for terrorist organizations to spread their ideology, recruit members, and obtain financial and logistic help from their supporters, all these factors easing the terrorists' cost for planning attacks.

A world with less privacy and more surveillance powers increases the terrorist' cost for planning and organizing attacks. First, surveillance legislation has a chilling effect on terrorism recruitment. Surveillance legislation chills the expression and dissemination of radical ideology and the advocacy of political violence. Since people who attend the meetings of a radical organizations are themselves more likely to engage in political violence, more stringent surveillance legislation increases the cost of recruitment for terrorist groups.[1]

Also, surveillance legislation has a chilling effect on the logistic and financial support from the individuals and communities that support the terrorist's objectives. For instance, if electronic and telephone data is retained for longer periods so the government can reconstruct the terrorist's connections even after a terrorist attack, these provisions alienates

[1]For example, in the United States, mosques have asked speakers to refrain from political messages in their sermons, such as criticism of U.S. foreign policy. Also, press reports shows that some people are avoiding mosques, preferring to pray at home (Watanabe and Esquivel 2009). Moreover, a recent survey that attempts to gage any changes in the Internet use among Muslim-American since 9/11 finds that 25.4% of respondents stated they were personally aware of other Muslims in the United States who changed their general activities after 9/11 because of a concern that the government may be monitoring their activities. And 11.6% respondents stated that they themselves have changed their internet behavior due to concerns of government surveillance (Sidhu 2007).

terrorists from interaction with individuals who do not want to leave traces of their connections with terrorists. Similarly, more surveillance powers deter people from being associated with potential terrorists which isolated terrorists from the communities in which they could hide to plan their attacks. All these factors make it harder for terrorists to plan attacks without raising suspicions.[2] Overall, if there are more privacy protections and implicitly more restrictions on surveillance powers the terrorist's cost for planning an attack is lower.

To recap the argument, the level of restrictions on surveillance powers affects both the government's cost for preventive investigation and the terrorist's cost for planning an attack. When we lower the level of restrictions on surveillance powers, the government's cost for preventive investigation decreases and the terrorist's cost for planning an attack increases. And we want to compare the probability of a terrorist attack in a world with more restrictions on surveillance powers vis-a-vis a world with less restrictions on surveillance powers.

Now, assuming that both the government and the terrorist are strategic actors, the government has to strategically decide how much effort to exert for preventive investigation and the terrorist has to strategically decide whether to plan an attack or not. In this strategic interaction, increasing the government surveillance powers has a direct and also an indirect (strategic) effect on both the government's and the terrorist's decisions. For one, fewer restrictions on surveillance make it more costly for the terrorist to plan an attack and also make it less costly for the government to exert effort to prevent a terrorist attack should the terrorist decide to plan an attack. Both these effects work in the same direction and induce the terrorist to be less likely to plan an attack when relaxing restrictions on surveillance powers. Second, fewer restrictions on surveillance powers make it less costly for the government to exert preventive investigation effort and make it more costly for the terrorist to plan an attack. In this case, the two effects work in opposite direction; the strategic effect induces the government to exert less preventive investigation effort when

[2]For example, press reports shows that surveillance has had a negative impact on Muslim charities organization and also on the financial donations of Muslims to their mosques due to fear of being associated with financing terrorist groups (Watanabe and Esquivel 2009).

relaxing restrictions on surveillance powers. This is essentially logic of anticipated reactions: fewer restrictions on surveillance imply that the terrorist has a higher cost of planning an attack and the government anticipates this effect when deciding the exert preventive investigation.

Now, the overall probability of a terrorist attack depends on both how likely is the terrorist to plan an attack and how likely is the government to prevent the attack should the terrorist plan one. What we want to know if how does the probability of a terrorist attack vary with the level of restrictions on surveillance powers. On the one hand, the terrorist is less likely to plan an attack when relaxing restrictions on surveillance powers and this effect decrease the probability of a terrorist attack. But on the other hand, the government is less likely to exert preventive investigation which increases the probability of a successful attack should the terrorist plans an attack. As a result, the overall effect is indeterminate and it is possible that the probability of a terrorist attack to increase when increasing government surveillance powers.

We also can say something how the security-enhancing policy compares to the government's most preferred surveillance policy. If the probability of a terrorist attack decreases when increasing surveillance powers, the government's most preferred policy and the security-enhancing policy are the same: the minimum possible level of restrictions on surveillance. However, if the probability of a terrorist attack increases when relaxing restrictions on surveillance powers, an agency problem emerges: the security-enhancing policy is different than the government's most preferred surveillance policy. The rationale is that the government pays a cost for exerting preventive investigation. The cost is strictly increasing in the level of restrictions on surveillance powers. Thus, the objective of the government is not only to minimize the probability of a terrorist attack but also its cost for exerting preventive investigation. The cost adds the further pressure and makes it for the government to want a lower level of restrictions than the security-enhancing level. Only when the probability of a terrorist attack is strictly decreasing with the level of legal restrictions, the government's

objective is aligned with the objective of minimizing the probability of a terrorist attack.

In the next section, I will develop a game-theoretic model that formalizes the above arguments. I want to emphasize that I abstract from many factors that might affect the probability of a terrorist attack and only focus on one variable: the level of restrictions on surveillance powers. By isolating this factor, I want to make progress with the theoretical conditions that link restrictions on surveillance powers and enhancing security. However, many other factors influence the motives and decisions of the terrorists and the government and thus implicitly the likelihood of a terrorist attack. Regarding the terrorists, some of these factors are the size of the terrorist networks, the quality of its members, and the size of the support community. Regarding the government, some of the factors are the design of security and intelligence agencies, the internal procedures and decision-making process within security agencies, and the culture of intelligence agencies. For example, some scholars have argued that Al Qaeda benefited from the division of responsibility between FBI and CIA, the lack of information at the top of the FBI and the FBI organizational culture oriented more toward criminal law rather than intelligence gathering (Posner 2007).

4 The Model

There are two players: the government and a suspected terrorist. The government does not know with certainty the suspected terrorist type: she can be either an innocent individual or a terrorist. The government knows ex-ante that the suspected terrorist is a terrorist with probability q.

The government chooses a level of preventive investigation effort that varies from no effort $e = 0$, to some maximum value, $\overline{e}$. That is the government chooses an action $e \in [0, \overline{e}]$. As mentioned, the level of effort can be interpreted as how much time, personnel, and resources the government allocates to collecting and analyzing information and monitoring the suspected terrorist. The terrorist makes a binary decision: she chooses whether to plan or

not a terrorist attack, $d_t \in \{PA, NPA\}$. The innocent individual has a dominant strategy: she never plans an attack. Since the innocent individual is not a strategic player, I will only consider the interaction between the government and the terrorist from now on.

The government and the terrorist make their decisions simultaneously. The rationale for modeling the strategic interaction between the government and the terrorist as a simultaneous interaction is that neither the government nor the terrorist observes the other party's action choice. That is terrorists do not observe whether the government is collecting and analyzing information about their whereabout or whether the government is monitoring their communications and behavior. Likewise, the government does not observe the terrorists' decision whether to plan an attack or not.

The outcome of the game is binary: a terrorist attack occurs or a terrorist attack does not occurs. Which outcome prevails depends on both the government's and the terrorist's actions. The technology that translates the government's and the terrorist's actions into the outcome of the game is a probability of a successful terrorist attack $p(e, d_t)$. I make several assumptions on the probability of a successful terrorist attack.

First, if the terrorist does not plan an attack or if the suspected terrorist is an innocent individual, the probability of a successful terrorist attack is 0, regardless of the government's effort level. Second, if the government chooses the maximum level of effort $e = \overline{e}$, the probability of successful terrorist attack is 0, regardless of the terrorist's decision. This assumption substantively implies that the government has enough resources to stop a terrorist attack should the suspected terrorist attempt an attack. Another way to see the assumption is this: Suppose that the government's effort level is interpreted as the number of agents the government allocates to investigate a suspected terrorist. The assumption implies that the government has the necessary number of agents that if chooses to allocate all of them to investigate the suspected terrorist, a terrorist attack will be stop with probability 1 in the contingency that the terrorist plans an attack. Third, if the government chooses no effort $e = 0$ and the terrorist plans an attack, i.e. $d_t = PA$, the probability of a successful attack

is 1. Fourth, if the terrorist plans an attack and the government chooses a level of effort different than $e = 0$ and $e = \overline{e}$, the probability of a successful terrorist attack decreases when the government chooses a higher effort level.

The government incurs a cost when it exerts preventive investigation effort. The cost $c_g(e, r)$ depends on the level of effort and the level of restrictions on surveillance powers. I assume that if the government chooses a higher level of effort, the government incurs a higher cost and if there are more restrictions on surveillance powers it is more costly for the government to exert preventive effort. Also, the terrorist incurs a cost for planning an attack $c_t(r, d_t)$ that depends on the level of restrictions on surveillance powers and the terrorist's decision . I assume that the cost is 0 if the terrorist does not plan an attack, i.e. $c_t(r, PNA) = 0$. And if the terrorist plans an attack, more restrictions on surveillance powers (and implicitly more privacy) decrease the cost of planning an attack.

The government and the potential terrorist get certain utility if the outcome of the game is no terrorist attack, $U_g(no\ attack)$ and $U_t(no\ attack)$, respectively. Also, the government and the terrorist get certain utility if the outcome of the game is a successful terrorist attack: $U_g(attack)$ and $U_t(attack)$, respectively. I define i_g as the government's utility difference $U_g(no\ attack) - U_g(attack) > 0$ and i_t as the terrorist's utility difference $U_t(attack) - U_t(no\ attack) > 0$.

Given these assumptions, we can write the government and the terrorist's expected utilities. The government's expected utility is the following:

$$\begin{aligned} EU_g &= q \cdot \{Pr(terrorist\ attack) \cdot U_g(attack) + (1 - Pr(terrorist\ attack)) \cdot U_g(no\ attack)\} \\ &\quad + (1 - q) \cdot U_g(no\ attack) - c_g(e, r) \end{aligned} \tag{1}$$

Also, the terrorist's expected utility is the following:

$$EU_t = Pr(terrorist\ attack) \cdot U_t(attack) + (1 - Pr(terrorist\ attack)) \cdot U_t(no\ attack) - c_t(d_t, r) \tag{2}$$

I also assume that the government prefers to exert the maximum level of effort and deter a terrorist attack from occurring if the terrorist plans a terrorist attack with certainty. Finally, I assume that the terrorist prefers to plan an attack if the government does not exert any preventive effort to investigate her. All the assumptions in this section are stated formally in the appendix.

5 The Surveillance Game

As I mentioned only the government and the terrorist are strategic actors in the model, the innocent individual has a dominant strategy not to plan an attack. As a result, we need to solve for the government's and the terrorist's optimal actions. Since the government has incomplete information about the suspected terrorist type, I solve for the Bayesian-Nash equilibrium of the game.

The surveillance game does not have an equilibrium in which the terrorist plans an attack with probability 1 or with probability 0. Suppose that the terrorist plans an attack with certainty. Then the government prefers to choose the maximum level of effort and the probability of a successful attack is zero. In this case the terrorist prefers to change its action and not to plan an attack since the outcome of the game is the same but the terrorist does not pay the cost of planning an attack. On the other hand, if the terrorist chooses not to plan an attack for sure the government's best strategy is to exert no preventive investigation effort since the outcome is the same but the government incurs a cost if it exerts a positive effort level. But in this case the terrorist prefers to change its action and plan an attack since the probability of a successful attack is 1 when the government does not exert any

preventive effort. Thus we cannot have an equilibrium in which the terrorist plans an attack with probability 1 or with probability 0. With some positive probability the terrorist pools with the innocent individual and chooses not to plan an attack.

Lemma: The surveillance game does not have an equilibrium in which the terrorist plays a pure strategy.

Thus, the terrorist plans a terrorist attack with some (non-degenerate) probability. Let t denote the probability with which the terrorist plans an attack. To find the Bayesian-Nash equilibrium of the game we need to find the optimal t^* and the government's optimal effort level e^*.

First, let us find the government's optimal level of effort. In order for the terrorist to be willing to plan an attack with some (non-degenerate) probability t, the government's optimal effort level is such that the terrorist is indifferent between planning an attack and not planning an attack. The indifference condition is:

$$U_t(no\ attack) = p(e, PA) \cdot U_t(attack) + (1 - p(e, PA)) \cdot U_t(no\ attack) - c_t(r, PA) \qquad (3)$$

The left-hand side of the equation represents the terrorist's payoff if the terrorist chooses not to plan an attack, i.e. $d_t = NPA$. The right-hand side of the equation represents the terrorist's payoff if he chooses to plan an attack, i.e $d_t = PA$. The government's optimal effort level $e^*(r, i_t)$ is the solution to the above equation. In the appendix I will show that the optimal effort level is unique.

Second, let us find the terrorist's optimal probability of planning a terrorist attack t^*. The terrorist's probability of planning an attack t is such that the government's optimal effort level is exactly $e^*(r, i_t)$, the level of effort that solves the terrorist's indifference condition. When the terrorist plans an attack with probability t, the government's expected utility is:

$$EU_g = q \cdot t \cdot p(e, PA) \cdot (U_g(attack) - U_g(no\ attack)) - c_g(e, r) + U_g(no\ attack) \qquad (4)$$

In the appendix, I show that a unique $t^*(r, q, i_g)$ exists so that the government's optimal level of effort is exactly $e^*(r, i_t)$. Given these results, we have the following proposition:

Proposition 1. The surveillance game has a unique Bayesian-Nash equilibrium. In this equilibrium, the government chooses an effort level $e^*(r, i_t)$ *and the terrorist plans an attack with probability* $t^*(r, q, i_g)$.

Next, I derive several comparative statics results on how the equilibrium actions $t^*(r, q, i_g)$ and $e^*(r, i_t)$ vary as functions of the exogenous parameters r, i_g, q, and i_t.

Corollary 1. The government's equilibrium level of effort increases in r *and* i_t. *The equilibrium probability that the terrorist plans an attack increases in* r *and decreases in* i_g *and* q.

The intuition for the results is the following: The terrorist is more likely to plan an attack if its benefit from a successful attack is higher, and this induces the government to increase its equilibrium effort level. The government is more likely to exert effort if its benefit for stopping a terrorist attack is higher, and this induces the terrorist to be less likely to plan an attack. The government's cost increases in the level of restrictions on surveillance powers, and this induces the terrorist to be more likely to plan an attack.

The comparative statics result that the government's equilibrium effort increases if there are more restrictions on surveillance powers seems counterintuitive. After all if there are more restrictions on surveillance powers, the government's cost is increasing and this seemingly would induce the government to decrease its equilibrium effort level. To see what is producing this counterintuitive result consider the situation in which the government is non-strategic: the government only takes into account how restrictions on surveillance powers affect its own payoff (not the terrorist's payoff), specifically its cost $c_g(e, r)$. In this case, the (non-strategic) optimal level of effort is indeed decreasing in the level of restrictions on surveillance since the government's cost for preventive investigation increases.

However, in the game-theoretic framework, how the level of restrictions on surveillance affects the equilibrium level of effort depends on the potential terrorist's payoff. Because a higher level of restrictions decreases the cost of the potential terrorist for planning an attack, the government chooses a higher level of surveillance effort to match the direction of how changing the level of restrictions impacts the terrorist's cost. In the strategic scenario, there is a logic of anticipated reaction: the government chooses its action depending on the impact of restrictions on surveillance powers on the terrorist's payoff. The comparative statics results that the equilibrium level of effort $e^*(r, i_t)$ increases in restrictions on surveillance captures this strategic effect.

The results that the equilibrium level of effort always increases if the level of restrictions on surveillance powers increases depends on the assumption that the potential terrorist's action space is dichotomous, an assumption that induces the terrorist to play a mixed strategy in equilibrium. In a mixed strategy, it is only the terrorist's payoff impacts the government's equilibrium level of effort while the non-strategic effect of restrictions on surveillance powers does not affect the government's equilibrium level of effort. If the terrorist chooses a continuous action: a level of planning an attack, both the strategic (indirect) effect and the non-strategic (direct) effect impact the equilibrium level of effort. However, it is possible that the strategic effect dominates the non-strategic effect and thus the equilibrium level of effort is increasing in the level of restrictions on surveillance powers just as in the previous model. I will show these more general results in the next sections.

Next, we can compute the government's and the terrorist's expected payoffs and determine how the payoffs vary as functions of the level of restrictions on surveillance powers. The government's expected payoff is:

$$EU_g(r) = t^*(r) \cdot p(e^*(r), PA) \cdot (U_g(attack) - U_e(no\ attack)) - c_g(e^*(r), r) + U_g(no\ attack) \quad (5)$$

In the appendix, I show that the government's payoff is strictly decreasing in the level

of restrictions on surveillance powers. And the terrorist's expected payoff is $EU_t = U_t(no\ attack)$ which is independent on the level of legal restrictions on surveillance.

Corollary 2. The government's expected payoff strictly decreases in r. The terrorist's expected payoff is independent of r.

The corollary shows that the level of restrictions on surveilance powers affects the government's but not the terrorist's expected payoff.

Corollary 3. The level of restrictions on surveillance powers that yields the highest expected payoff to the government is the minimum.

This corollary is relevant if we want to answer the question of what is the optimal institutional allocation of authority to decide the level of restrictions on surveillance powers.

6 Enhancing Security

Now, let us analyze how the equilibrium probability of a (successful) terrorist attack varies with the level of restrictions on surveillance powers. The equilibrium probability of a (successful) terrorist attack is the probability with which the terrorist plans an attack $t^*(r)$ times the probability that the terrorist attack is successful $p(e^*(r), PA)$. Thus, equilibrium probability of a terrorist attack is:

$$\Pr(terrorist\ attack) = t^*(r) \cdot p(e^*(r), PA). \tag{6}$$

Let us denote the level of restrictions on surveillance powers by $r \in [r_{\min}, r_{\max}]$. Our objective is to find the level of restrictions on surveillance powers that minimizes the probability of a successful terrorist attack:

$$\min_{r \in [r_{\min}, r_{\max}]} \Pr(terrorist\ attack) \tag{7}$$

The probability of a terrorist attack might be decreasing or increasing in r because $t^*(r)$ is increasing but $p(e^*(r), PA)$ is decreasing in r. Thus, the effect of increasing the level of restrictions on surveillance powers on the equilibrium probability of a terrorist attack is indeterminate.

To illustrate the indeterminacy, I present one example in which the equilibrium probability of a terrorist attack decreases in the level of restrictions on surveillance powers. Let the government's action space be $[0, 1]$, the government's cost be $c_g = e^2 \cdot r$, the terrorist's cost be $c_t = 1 - r$, the probability of a successful terrorist attack be $p(e, PA) = 1 - e$, the government's utility difference be $i_g = 2$, the terrorist's utility difference be $i_t = 1$ and let r be in $[\frac{2}{3}, \frac{3}{4}]$. Also, let $q = 1$. Under these specifications, the equilibrium probability of a terrorist attack is $\Pr(\textit{terrorist attack}) = r^2 \cdot (1 - r)$ which is strictly decreasing in r.

Moreover, we can also note that the optimal (security-enhancing) level of restrictions on surveillance powers might be different than the government's optimal level of legal restrictions on surveillance powers. The government incurs a cost for exerting preventive effort, a cost that is increasing in the level of restrictions on surveillance powers. As a result, the government's objective is not only to minimize the probability of a terrorist attack but also its cost. The level of restrictions on surveillance impacts not only the probability of a terrorist attack, but also the government's cost for preventive investigation. If we consider only the effect of the level of restrictions on the government's cost, relaxing the level of restrictions on surveillance powers is always beneficial because it reduces the government's cost. In equilibrium, when we relax restrictions on surveillance powers, the beneficial effect of decreasing the government's cost completely offsets the negative effect of increasing the probability of successful attack (in the instance in which the probability of a terrorist attack increases when we relax legal restrictions on surveillance). In equilibrium, an agency problem might exist: the government's optimal level of legal restrictions on surveillance r_{min} (see Corollary 3) is different than the security-enhancing level of restrictions on surveillance powers.

7 Robustness

One possible worry might be that the terrorist chooses a mixed strategy which produces the counterintuitive result that the government is less likely to exert preventive investigation effort. In this section, I will show that it is not the mixed strategy that produces the results of the previous analysis. I will model the terrorist action's choice as a continuous variable, i.e. a level of attack effort, and show that the same results can be obtained in a pure strategy Bayesian-Nash equilibrium.

Let the government choose an effort level $e \in [0, \overline{e}]$ and the terrorist chooses an attack effort level $a \in [0, \overline{a}]$. Given the players' actions, the probability of a successful terrorist attack is a function of both variables $p(a, e)$ and is increasing in a and decreasing in e. Also, the government pays a cost for preventive investigation $c_g(e, r)$ which is increasing in e and r and the terrorist pays a cost for planning an attack, i.e. $c_t(a, r)$ which is increasing in a and decreasing in r. The innocent individual has a dominant strategy no to plan an attack, i.e $a = 0$. Just as in the previous model, the government knows that the suspected individual is a terrorist with probability q.

The government and the terrorist choose their actions simultaneously. The government maximization problem is:

$$\max_{e}\{-q \cdot p(e, a) \cdot i_g - c_g(e, r)\} \tag{8}$$

And the terrorist maximization problem is:

$$\max_{a}\{p(e, a) \cdot i_t - c_t(a, r)\} \tag{9}$$

The equilibrium actions are the solutions $e^*(r)$ and $a^*(r)$ to the following system of simultaneous equations:

$$-\frac{\partial c_g(e, r)}{\partial e} - q \cdot i_g \cdot \frac{\partial p(e, a)}{\partial e} = 0 \tag{10}$$

$$-\frac{\partial c_t(a,r)}{\partial a} + i_t \cdot \frac{\partial p(e,a)}{\partial a} = 0 \tag{11}$$

The game cannot be analyzed in this general form. The problem is that we cannot derive the the equilibrium actions (and implicitly the equilibrium probability of a terrorist attack) and say something about how they vary as a function of the level of restrictions on surveillance. However, we can show that the effect identified in the previous model exists and that it is possible for the government's level of effort to increase with an increase in the level of restrictions and the probability of a terrorist attack to increase when we relax the level of restrictions on surveillance powers.

Assuming that we can write the terrorist's action as an implicit function of r and e and replacing the terrorist's action in the government's equation we get:

$$-\frac{\partial c_g(e,r)}{\partial e} - q \cdot i_g \cdot \frac{\partial p(e,a(e,r))}{\partial e} = 0 \tag{12}$$

Assuming also that we can write the government's effort level as an implicit function of r, the direction of how the equilibrium level of effort varies with an increase in the level of restrictions on surveillance powers is indeterminate. To see this taking the derivative of the above equation with respect to r we get an expression that has both a negative part $-\frac{\partial^2 c_g(e,r)}{\partial e \partial r}$ and a positive part $-i_g \cdot \frac{\partial^2 p(e,a(e,r))}{\partial e \partial a} \cdot \frac{\partial a(e,r)}{\partial r}$. The negative part is the non-strategic effect that comes through the government's cost and the positive part represents the strategic effect that comes through effect of the level of restrictions on surveillance powers on the terrorist's payoff.

To illustrate this indeterminacy, I present one example in which it decreases in the level of legal restrictions on surveillance powers. Let the government's action space be $[0,1]$ and the terrorist's action space be $[0,1]$. The probability of a successful attack is $p(a,e) = a \cdot (1-e)$ a function that is increasing in a and decreasing in e. The government's cost is $c_g(e,r) = \frac{1}{2} \cdot e^2 \cdot r$ and th terrorist's cost is $c_t(a,r) = a^2(1-r)$. Also let the government's and the terrorist's

payoff when an attack does not occur be 0, the government's payoff when an attack occur be -1 and the terrorist's payoff when an attack occurs be 1. And let r be in $[\frac{8}{10}, \frac{9}{10}]$ and $q = 1$.

Solving the simultaneous system of equations, we obtain the equilibrium actions: $e^*(r) = \frac{1}{1+2\cdot r-2\cdot r^2}$ and $a^*(r) = \frac{r}{1+2\cdot r-2\cdot r^2}$. The equilibrium actions $e^*(r)$ and $a^*(r)$ are strictly increasing in r.

The probability of a terrorist attack is: $\Pr(\textit{terrorist attack}) = \frac{2\cdot r^2\cdot(1-r)}{(1+2\cdot r-2\cdot r^2)^2}$. The probability of a terrorist attack is strictly decreasing in r so to minimize it the optimal security enhancing policy is $r = \frac{9}{10}$. And the government's payoff is: $EU_g(r) = \frac{-r\cdot(-1-4\cdot r-4\cdot r^2)}{2\cdot(1+2\cdot r-2\cdot r^2)^2}$. The expression is strictly decreasing in r so the government's optimal policy choice is $r = \frac{8}{10}$.

The basic result in the paper is also robust to changing the sequence of the interaction and analyze a situation in which the government moves first and commits to an action and then the potential terrorist chooses its action. To illustrate this, here is an example in which the interaction is sequential. Let the government's action space be $[0, 1]$ and the terrorist's action space be $[0, 1]$. The probability of a successful attack is $p(a, e) = a \cdot (1 - e)$ a function that is increasing in a and decreasing in e. The government pays a cost $c_g(e, r) = \frac{1}{2} \cdot e^2 \cdot r$ and the terrorist pays an attack cost $c_t(a, r) = a^2(1 - r)$. Also let the government's and the terrorist's payoff when an attack does not occur be 0, the government's payoff when an attack occur be -1 and the terrorist 's payoff when an attack occurs be 1. And let r be in $[\frac{8}{10}, \frac{9}{10}]$ and $q = 1$.

Solving the game by backward induction, we obtain the the equilibrium actions: $e^*(r) = \frac{1}{1+r-r^2}$ and $a^*(r) = \frac{l}{2\cdot(1+r-r^2)}$. The equilibrium action $e^*(r)$ and $a^*(r)$ are strictly increasing in r.

The probability of a terrorist attack is: $\Pr(\textit{terrorist attack}) = \frac{r^2\cdot(1-r)}{2\cdot(1+r-r^2)^2}$. The probability of a terrorist attack is strictly decreasing in r so to minimize it the optimal choice is $r = \frac{9}{10}$. Also, the government's expected payoff is: $EU_g(r) = -\frac{r}{2\cdot(1+r-r^2)}$. This expected payoff is strictly decreasing in r so the government's optimal r is $r = \frac{8}{10}$.

8 Discussion and Policy Implications

8.1 Surveillance Powers and Enhancing Security

Increasing the government surveillance powers has been a common trend in Western liberal democracies as part of policy response to the (perceived) terrorist threat. In the name of fighting terrorism, liberal democratic states have changed the policy balance between protecting individual privacy and the government's surveillance powers in favor of the latter. And the main policy justification was to help the government preventing terrorist attacks. A successful preventing strategy requires that the government identifies terrorist plots while at the planning stage and this cannot be done effectively unless the government has access to private information about individual's social networks and whereabouts.

Probably the best know surveillance legislation is the 2001 Patriot Act. Among the most controversial provisions of this legislation are the following. First, the Patriot Acts allows for "'sneak and peak"', meaning that suspected individuals will not learn that the government has placed them under surveillance or has entered their private space in search of information.[3] Second, the Patriot Act increases the FBI's ability to bypass warrant requirements. The FBI can obtain information via administrative subpoena, called National Security Letters (NSL), information that includes credit card records, bank account numbers, and data pertaining to internet use.[4] Third, the Patriot Act legalizes roving surveillance, meaning that the FBI can wiretap every single phone line, mobile communications device or Internet connection that a suspected individual might be using, without ever having to identify the suspect by name.

However, this paper shows that relaxing restrictions on surveillance enhances security only under certain conditions. Most of the existing debate has focused on the cost imposed

[3]The government has only to show a reasonable cause that noticing individuals may cause an appropriate result.

[4]The application of NSL to Internet Service Provider's immediately implicated a broad range of institutions, including any library, school, or company that provides physical access to Internet.

by privacy protections on the government's capacity to carry preventive investigations in order to prevent a terrorist attack. The assumption is that fewer restrictions on surveillance powers allows the government to be more effective in carrying preventive investigation and consequently to be more likely to prevent terrorist attacks. But the level of restrictions on surveillance powers/ privacy protections affects also the terrorists' capacity to plan attacks, and I show that we need to take into account how much decreasing privacy protections affects the capacity of terrorist's to plan attacks. If the government is a strategic actor, the negative effect on lowering privacy protections on terrorist's payoff will be anticipated by the government with the possibility of increasing the probability of a terrorist attack.

8.2 The Design of Surveillance Policy

Another feature of the antiterrorism surveillance legislation is that the agencies usually in charged with implementing the counterterrorism policy have also crafted the surveillance legislation. For example, in the United State, the Justice Department and the FBI drafted most of the surveillance provisions in the Patriot Act. In addition, some of the surveillance provisions were not new. The FBI has proposed delayed-notice search warrants and the roving surveillance in an anti-drug bill and a bankruptcy bill but Congress has rejected these previous efforts.

The policy justification for the security agencies driven surveillance legislation is that these agencies have specific information about fighting terrorism. The analysis however suggests that the security agencies might not be the best institutional actors to design the surveillance legislation even if they have better information about fighting terrorism. The level of restrictions on surveillance powers that maximizes security is likely to be different than the security agencies' most preferred level. The security agencies pay the surveillance costs associated with limitation of their surveillance actions and this cost introduces a wedge between the objective of maximizing security and the objective of maximizing security while minimizing the surveillance costs.

9 Conclusion

In this paper, I have analyzed whether increasing the government surveillance powers helps reduce the probability of a terrorist attack. I have shown that, under certain conditions, the probability of a terrorist attack is higher in a world with fewer restrictions on surveillance powers vis-a-vis a world with more restrictions on surveillance powers. I have also shown that an agency problem emerges: the optimal security enhancing surveillance policy is different than the government's most preferred surveillance policy if the probability of a terrorist attack does not decrease with an increase in the level of surveillance powers. These findings contribute to the current public and scholarly debate regarding the trade-off between security and civil liberties in the context of counterterrorism.

10 Appendix

10.1 The Model

I make the following assumptions on the probability of a successful terrorist attack:

Assumption 1: If the terrorist does not plan an attack, $p(e, NPA) = 0$ *for any* $e \in [0, \overline{e}]$. *If the terrorist plans an attack,* $p(e = 0, PA) = 1$; $p(e = \overline{e}, PA) = 0$; *and* $0 < p(e, PA) < 1$ *for any* $e \in (0, \overline{e})$.

Assumption 2: The probability of a successful terrorist attack decreases in e *that is,* $\frac{\partial p(e,PA)}{\partial e} < 0$ *for* $e \in (0, \overline{e})$. *The probability of a successful terrorist attack presents decreasing marginal returns in* e, $\frac{\partial^2 p(e,PA)}{\partial e^2} \geq 0$.

I make the following assumptions on the government's cost for preventing a terrorist attack:

Assumption 3: The government's cost $c_g(e, r)$ *increases in* e *and* r, *that is* $\frac{\partial c_g(e,r)}{\partial e} > 0$ *and* $\frac{\partial c_g(e,r)}{\partial r} > 0$. *If the government does not exert effort* $e = 0$, then $c_g(e = 0, r) = 0$.

Assumption 4: The marginal cost is convex in e, that is $\frac{\partial^2 c_g(e,r)}{\partial e^2} > 0$.

Assumption 5: The marginal cost for effort e *increases in* r, *that is* $\frac{\partial^2 c_g(e,r)}{\partial e \partial r} > 0$.

I make the following assumptions on the terrorist's cost for planning an attack:

Assumption 6: The cost for planning an attack decrease with an increase in the level of restriction on surveillance powers which implies that $\frac{\partial c_t(r,d_t)}{\partial r} < 0$. *If the terrorist chooses not to plan an attack*, i.e $d_t = NPA$, *the cost for planning an attack is* 0, i.e. $c_t(r, PNA) = 0$.

Next, I make an assumption on the benefit of preventive investigation effort for the government in the case that the terrorist plans an attack for sure.

Assumption 7: If the terrorist plans an attack for sure, the marginal cost is less that the marginal benefit for any effort level e, *that is* $\frac{\partial c_g(e,r)}{\partial e} < q \cdot i_g \cdot \mid \frac{\partial p(e,PA)}{\partial e} \mid$

This last assumption states that if the effort for preventive investigation marginally increases, the government's benefit from such a marginal increase is higher (since with $\frac{\partial p(e,PA)}{\partial e}$ decreases the probability of a terrorist attack and the difference in payoff is $i_g \cdot q$) if the terrorist plans an attack for sure.

In addition, I assume that the terrorist prefers to attack if the government does not exert any effort to prevent a terrorist attack: $U_t(attack) - c_t(r) > U_t(no\ attack) \Rightarrow i_t > c_t(r, PA)$.

Assumption 8: $i_t > c_t(r_{\min})$.

This condition states formally that even if the level of restrictions on surveillance powers is at the minimum, the terrorist plans an attack if she knows that the government does not exert any effort.

10.2 The Surveillance Game

Lemma: The surveillance game does not have an equilibrium in which the terrorist plays a pure strategy.

Proof. If the terrorist does not plan an attack, the government's best strategy is $e = 0$ since $c_g(e = 0, r) = 0$ and $p(e; NPA) = 0$ *for any* $e \in [0, \overline{e}]$. But the terrorist prefers to plan an attack if the government chooses $e = 0$. And if the terrorist plans an attack for sure, the government's best strategy is the solution to following maximization problem:

$$q \cdot p(e, PA) \cdot (U_g(attack) - U_g(no\ attack)) - c_g(e, r) + U_g(no\ attack) \tag{13}$$

We can simplify maximization problem to:

$$\max_e \{-q \cdot p(e, PA) \cdot i_g - c_g(e, r)\} \tag{14}$$

The first order condition is:

$$-\frac{\partial c_g(e, r)}{\partial e} - q \cdot i_g \cdot \frac{\partial p(e, PA)}{\partial e} = 0 \tag{15}$$

The optimal solution is $e = \overline{e}$ because $\frac{\partial c_g(e,r)}{\partial e} < q \cdot i_e \cdot \mid \frac{\partial p(e,PA)}{\partial e} \mid$. And because the probability of a terrorist attack will be $p(e = \overline{e}, PA) = 0$, the terrorist would prefer not to plan an attack. ■

Proposition 1. The surveillance game has a unique Nash equilibrium. In this equilibrium, the government chooses an effort level $e^*(r, i_t)$ *and the terrorist plans an attack with probability* $t^*(r, i_g)$.

Proof. In order for the terrorist to be willing to plan an attack with some (non-degenerate) probability t, the government's optimal effort level is such that the terrorist is indifferent between planning an attack and not planning an attack. The indifference condition is:

$$U_t(no\ attack) = p(e, PA) \cdot U_t(attack) + (1 - p(e, PA)) \cdot U_t(no\ attack) - c_t(r, PA) \tag{16}$$

From the above equation, we have $p(e, PA) = \frac{c_t(r,PA)}{i_t}$. Because $0 < \frac{c_t(r,PA)}{i_t} < 1$ and

$p(e, PA)$ is strictly decreasing in e, a unique $e^*(r)$ satisfies the equation.

The government's expected payoff is:

$$EU_g = q \cdot t \cdot p(e, PA) \cdot (U_g(attack) - U_g(no\ attack)) - c_g(e, r) + U_g(no\ attack) \tag{17}$$

The government's optimal effort level is the solution to the following maximization problem:

$$\max_e \{-q \cdot p(e, PA) \cdot i_g \cdot t - c_g(e, r)\} \tag{18}$$

The first order condition is:

$$-\frac{\partial c_g(e, r)}{\partial e} - t \cdot q \cdot i_g \cdot \frac{\partial p(e, PA)}{\partial e} = 0 \tag{19}$$

Also, we have $t^*(r) = -\frac{\frac{\partial c_g(e^*(r), r)}{\partial e}}{q \cdot i_g \cdot \frac{\partial p(e^*(r), PA)}{\partial e}}$. Because $\frac{\partial c_g(e,r)}{\partial e} < q \cdot i_g \cdot \mid \frac{\partial p(e,PA)}{\partial e} \mid$ then $0 < t < 1$ for any $e \neq 0$. Also, since $t^*(r)$ is strictly increasing in r, $t^*(r)$ is unique. Thus, we have a unique Bayesian Nash equilibrium.

■

Corollary 1. The government's equilibrium effort increases in r and i_t. The equilibrium probability that the terrorist plans an attack increases in r and decreases in i_g and q.

Proof. The government's equilibrium effort is the solution to the following equation: $p(e, PA) = \frac{c_t(r, PA)}{i_t}$. We can observe that $e^*(r)$ is strictly increasing in r since $p(e, PA)$ is strictly decreasing in e and $c_t(r, PA)$ is strictly decreasing in r, that is $\frac{\partial e^*(r)}{\partial r} > 0$. Also, $e^*(r, i_t)$ is strictly increasing in i_t since $\frac{c_t(r,PA)}{i_t}$ is strictly decreasing in i_t and $p(e, PA)$ is strictly decreasing in e.

To show that the probability that the terrorist attack decreases in r we need to show that $\frac{\partial t^*(r)}{\partial r} > 0$. We have $\frac{\partial t^*(r)}{\partial r} = \frac{(\frac{\partial^2 c_g(e^*(r), r)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} + \frac{\partial c_g(e^*(r), r)}{\partial e \partial r})(-\frac{\partial p(e^*(r))}{\partial e}) + \frac{\partial^2 p(e^*(r))}{\partial e^2} \cdot \frac{\partial c_g(e^*(r), r)}{\partial e}}{(\frac{\partial p(e^*(r))}{\partial e})^2}$.

And $\frac{\partial t^*(r)}{\partial r} > 0$ since $-\frac{\partial p(e^*(r))}{\partial e} \cdot \frac{\partial^2 c_g(e^*(r), r)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} > 0$; $(\frac{\partial c_g(e^*(r), r)}{\partial e \partial r})(-\frac{\partial p(e^*(r))}{\partial e}) > 0$; and

$\frac{\partial^2 p(e^*(r))}{\partial e^2} \cdot \frac{\partial c_g(e^*(r),r)}{\partial e} > 0.$

Also, we have $\frac{\partial t^*(r,i_g,q)}{\partial i_g} < 0$ since $t^*(r,i_g) = -\frac{\frac{\partial c_g(e^*(r),r)}{\partial e}}{q \cdot i_g \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}$ and $-\frac{\frac{\partial c_g(e^*(r),r)}{\partial e}}{q_g \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}$ is strictly decreasing in i_g.

Also we have $\frac{\partial t^*(r,i_g),q}{\partial q} < 0$ since $t^*(r,i_g) = -\frac{\frac{\partial c_g(e^*(r),r)}{\partial e}}{q \cdot i_g \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}$ and $-\frac{\frac{\partial c_g(e^*(r),r)}{\partial e}}{q_g \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}$ is strictly decreasing in q.

■

Corollary 2. The government's expected payoff strictly decreases in r. The terrorist's expected payoff is independent of r.

Proof. For the terrorist we have $U_t(r) = U_t(no\ attack)$ which is independent of r.The government's expected payoff is:

$$EU_g(r) = q \cdot t^*(r) \cdot p(e^*(r), PA) \cdot (U_g(attack) - U_g(no\ attack)) - c_g(e,r) + U_g(no\ attack). \quad (20)$$

This expression simplifies to the following maximization:

$$\max_r \{-q \cdot t^*(r) \cdot p(e^*(r), PA) \cdot i_g - c_g(e^*(r), r)\} \quad (21)$$

We have:

$$\frac{\partial EU_g(r)}{\partial r} = -\frac{c_g(e^*(r),r)}{\partial e} \cdot \frac{\partial e^*(r)}{\partial r} - \frac{\partial c_g(e^*(r),r)}{\partial r} + \frac{\frac{\partial^2 c_g(e^*(r),r)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} \cdot p(e^*(r),PA) \cdot \frac{\partial p(e^*(r)),PA}{\partial e}}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2}$$
$$+ \frac{(\frac{\partial p(e^*(r)),PA}{\partial e})^2 \cdot \frac{\partial e^*(r)}{\partial r} \cdot \frac{\partial c_g(e^*(r),r)}{\partial e})}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2} - \frac{\frac{\partial^2 p(e^*(r)),PA}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} \cdot \frac{\partial c_g(e^*(r),r)}{\partial e} \cdot p(e^*(r)),PA}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2} + \frac{\frac{\partial^2 c_g(e^*(r),r)}{\partial r \partial e} \cdot p(e^*(r),PA) \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2}.$$

This expression reduces to this:

$$-\frac{\partial c_g(e^*(r),r)}{\partial r} + \frac{\frac{\partial^2 c_g(e^*(r),r)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} \cdot p(e^*(r),PA) \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2} - \frac{\frac{\partial^2 p(e^*(r),PA)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} \cdot \frac{\partial c_g(e^*(r),r)}{\partial e} \cdot p(e^*(r),PA)}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2}$$
$$+ \frac{\frac{\partial^2 c_g(e^*(r),r)}{\partial r \partial e} \cdot p(e^*(r),PA) \cdot \frac{\partial p(e^*(r),PA)}{\partial e}}{(\frac{\partial p(e^*(r),PA)}{\partial e})^2}.$$

The above expression is strictly decreasing in r since:

$-\frac{\partial c_g(e^*(r),r)}{\partial r} < 0$; $\frac{\partial^2 c_g(e^*(r),r)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} \cdot p(e^*(r), PA) \cdot \frac{\partial p(e^*(r))}{\partial e} < 0$ since $\frac{\partial^2 c_g(e^*(r),r)}{\partial e^2} > 0$, $\frac{\partial e^*(r)}{\partial r} > 0$, $p(e^*(r, PA)) > 0$, and $\frac{\partial p(e^*(r),PA)}{\partial e} < 0$; as well as $-\frac{\partial p(e^*(r),PA)}{\partial e^2} \cdot \frac{\partial e^*(r)}{\partial r} \cdot \frac{\partial c_g(e^*(r),r)}{\partial e} \cdot p(e^*(r), PA) < 0$ since $\frac{\partial p(e^*(r),PA)}{\partial e^2} \geq 0$; $\frac{\partial e^*(r)}{\partial r} > 0$; $\frac{\partial c_g(e^*(r),r)}{\partial e} > 0$; and $p(e^*(r), PA) > 0$.

Thus, the government's expected payoff is strictly decreasing in r.

■

Corollary 3. The level of restrictions on surveillance powers that yields the highest expected payoff to the government is the minimum.

Proof. Since the government's expected payoff if strictly decreasing in r the optimal r from the government's perspective is $r_{\min}$.

■

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