Suicidal Terrorism and Discriminatory Screening: An Efficiency-Equity Trade-off.

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Abstract

Recent world events have cast a spotlight on what role, if any, discriminatory screening should play in aircraft security. This paper argues that if observable characteristics indicate differing probabilities of committing acts of terrorism, then following a non-discriminatory screening policy that fails to utilise those observable characteristics may be pareto-dominated by a screening policy that discriminates based on observable characteristics, even if agents are risk-neutral.

Keywords: Terrorism, Discriminatory Screening, Racial Profiling, Pareto Optimality

JEL codes: K43, L93

1. INTRODUCTION

Recent world events have cast a spotlight on what role discriminatory screening, including racial profiling, should play in aircraft security. This paper argues that if observable characteristics indicate differing probabilities of committing acts of terrorism, then following a non-discriminatory screening policy that fails to utilise those observable characteristics may be pareto-dominated by a screening policy that discriminates based on observable characteristics, even if agents are risk-neutral.

In the following section, related literature is outlined. Section 3 contains a simple theoretical model, and section 4 numerical examples. Section 5 concludes.

2. RELATED LITERATURE

A number of papers have addressed the optimal response to terrorist acts. Most have assumed that terrorists are rational agents who value their lives, and negotiators can utilise this fact in handling terrorist crises. For example, Lapan and Sandler (1993) use a two-period bargaining model in which the government extracts a signal from the first period on the capabilities of the terrorists before deciding how to respond in the second period. Lapan and Sandler (1988) analyse when it is optimal for the government to pre-commit to not negotiating with rational terrorists, while Lee (1988) argues that retaliation against terrorist organisations and the countries that sponsor them in response to terrorist acts is often desirable. Atkinson, Sandler and Tschirhart (1987) empirically test a number of bargaining-theory hypotheses, while Cauley and Im (1988) evaluate the effectiveness of a number of antiterrorist measures, and estimate the substitution effect as rational terrorists move from one mode of attack to another in response to these measures.

However, these papers offer limited guidance on the latest manifestation of terrorism, where terrorists do not value their own lives. Wintrobe (2003) argues that suicidal terrorism may be the rational response of an individual who gives up their autonomy in exchange for solidarity, and commits suicide for the sake of a group. If this exchange is complete, then attempts to thwart suicidal terrorism by punishing would-be terrorists may not be successful, and may even be counterproductive, due to the characteristics of individuals who are likely to become terrorists. Enders and Sandler (2002) also argue that if terrorists do not value their own lives, then policies that rely on incentive effects to lower the incidence of terrorism may be impotent; the only way to stop attacks is via direct action, for example by apprehending would-be terrorists. Sandler and Lapan (1988) study the impact of deterrence expenditure (which may include direct actions) when terrorists have multiple possible targets, and can substitute between them. They show that the non-cooperative solution between possible targets will generally lead to an inefficient level of deterrence; over deterrence in the case of domestic terrorism, but sometimes under deterrence in the case of transnational terrorism.

In this paper, the focus is on the efficient use of screening, which is an example of a direct, costly deterrence measure, where the source of possible inefficiency comes from a heterogeneous population with differing predispositions to commiting terrorist acts.

3. THEORETICAL MODEL

3.1 One type of agent

Suppose there are a large number of agents who would choose to travel in a risk-free world, a small portion of whom are terrorists. Let α be the probability that any one passenger is a terrorist. All agents wish to travel, but if any terrorist travels, all travelling agents die and lose utility d. Suppose that it is possible, at a cost of s per passenger, to screen travellers to reduce the probability of terrorists travelling. Further, the probability that each terrorist is detected by screening is $p(s), p' > 0, p'' < 0$, and this probability is independent across terrorists. Therefore the probability that a person is a terrorist who is not detected is given by $\alpha(1 - p(s))$.

For simplicity, suppose that

$$p(s) = (s - \epsilon)/s \tag{1}$$

where $\epsilon \leq s$ and ϵ measures the difficulty in detecting terrorists. Then the probability that any agent is an undetected terrorist is $\alpha\epsilon/s$. If being a terrorist is an independent event, the number of terrorists who are not detected by screening is Poisson-distributed, and the probability that m terrorists are not detected is

$$Prob(m) = \frac{e^{-\alpha\epsilon/s}(\alpha\epsilon/s)^m}{m!}. \tag{2}$$

If any one or more terrorists pass screening, all passengers die. Therefore the probability that passengers survive is

$$Prob(0) = e^{-\alpha\epsilon/s}. \tag{3}$$

Now suppose that passengers are risk-neutral, and pay any screening costs. If they travel and arrive alive, they receive utility u. Agents will travel if

$$ue^{-\alpha\epsilon/s} - d(1 - e^{-\alpha\epsilon/s}) - s > 0. \tag{4}$$

The marginal passenger who chooses to travel will have $u = u^*$ that satisfies

$$u^* = e^{\alpha\epsilon/s}(d + s) - d, \tag{5}$$

and if $u \sim U(0, 1)$, total welfare will be given by

$$\begin{aligned} W &= \int_{u^*}^{1} [ue^{-\alpha\epsilon/s} - d(1 - e^{-\alpha\epsilon/s}) - s]du \\ &= \frac{1}{2}e^{-\alpha\epsilon/s}[1 + d - e^{\alpha\epsilon/s}(d + s)]^2. \end{aligned} \tag{6}$$

The optimal degree of screening can then be determined by maximising W with respect to s. The first order condition is given by

$$\frac{1}{2}e^{-\alpha\epsilon/s}(\frac{\alpha\epsilon}{s^2})[1 + d] + \frac{1}{2}(\frac{\alpha\epsilon}{s^2})[s + d] - 1 = 0. \tag{7}$$

Now suppose that the probability of a terrorist being undetected is small so that

$$\frac{\alpha\epsilon}{s}e^{-\alpha\epsilon/s} \approx \frac{\alpha\epsilon}{s}, \tag{8}$$

so that no travellers fail to travel on account of the terrorist threat (an approximation we will relax in section 4). Then, taking the appropriate root of the resulting quadratic, the optimal degree of screening will satisfy

$$s^* = \frac{\alpha\epsilon + \sqrt{\alpha^2\epsilon^2 + 8\alpha\epsilon(1 + 2d)}}{4}, \tag{9}$$

where $s^* > 0$. Under the same approximation, $u^* = s^*$ and

$$W^* = \frac{1}{2}[1 - s^*]^2, \tag{10}$$

and $\frac{\partial W^*}{\partial \alpha} < 0, \frac{\partial W^*}{\partial d} < 0$.

3.2 Two types of agents; non-discriminatory policy

Now suppose that there are equal numbers of two types of agents (I and II), but terrorists are only drawn from type I. They pay $s(I)$ and $s(II)$ screening cost, and proportions of $P(I)$ and $P(II)$ choose to travel respectively, so that total screening revenue per traveller is given by

$$\bar{s} = \frac{P(I)s(I) + P(II)s(II)}{P(I) + P(II)}. \tag{11}$$

If only non-discriminatory policies are pursued, agents of both types are screened with the same frequency, and pay the same screening cost, so that $s(I) = s(II) = \bar{s}$. Then, under approximation (8), the optimal degree of screening and welfare will be identical to that in 3.1, so that

$$W(I)^* = \frac{1}{2}[1 - s^*]^2; \quad W(II)^* = \frac{1}{2}[1 - s^*]^2, \tag{12}$$

where $\bar{s} = s^*$ in (9) above.

3.3 Two types of agents; pareto improvement (I)

Note that with the non-discriminatory policy in place, screening of type II agents (from which terrorists are not drawn) is a dead-weight loss. If only type I agents are screened, and bear the cost of being screened, then $s(I) = s^*, s(II) = 0$, and under approximation (8), the respective welfare's of the two types are

$$W(I)^* = \frac{1}{2}[1 - s^*]^2; \quad W(II)^* = \frac{1}{2}. \tag{13}$$

Type I agents are no worse off, while type II agents are better off so, ignoring the welfare of would-be terrorists, this represents a pareto-improvement. However, type II agents are now better off than type I agents, so this is not an equitable outcome.

3.4 Two types of agents; pareto improvement (II)

Other pareto improvements are also possible, including one that makes agents of both types equally well off. Suppose, for example that only type I agents are screened, but the cost of being screened is paid equally by agents of both types. Note that if being screened entail's inconvenience for screened passengers, sharing the cost of screening in this way would entail the non-screened type compensating the screened type for their inconvenience (the "screened passengers receive free upgrades" scenario). Then the probability that a terrorist is not detected is given by $p(s) = (\bar{s}(I) - \epsilon)/\bar{s}(I)$, where

$$\bar{s}(I) = \frac{[P(I) + P(II)]s}{P(I)} \tag{14}$$

is the total screening revenue per type I traveller, and s is the screening cost paid by all agents. Again, under approximation (8), $P(I) = P(II)$ and the marginal passenger of each type now satisfies

$$u^* = e^{\alpha\epsilon/2s}(d + s) - d, \tag{15}$$

total welfare is

$$W = \frac{1}{2}e^{-\alpha\epsilon/2s}[1 + d - e^{\alpha\epsilon/2s}(d + s)]^2, \tag{16}$$

and the optimal degree of screening solves

$$\frac{1}{2}e^{-\alpha\epsilon/2s}(\frac{\alpha\epsilon}{2s^2})[1 + d] + \frac{1}{2}(\frac{\alpha\epsilon}{2s^2})[s + d] - 1 = 0, \tag{17}$$

or under approximation (8),

$$s^{**} = \frac{\alpha\epsilon + \sqrt{\alpha^2\epsilon^2 + 16\alpha\epsilon(1 + 2d)}}{8}. \tag{18}$$

Note that welfare is now given by

$$W(I)^{**} = \frac{1}{2}[1 - s^{**}]^2; \quad W(II)^{**} = \frac{1}{2}[1 - s^{**}]^2, \tag{19}$$

so both types of agents enjoy the same level of welfare. Note further that

$$s^* > s^{**} > \frac{1}{2}s^*, \tag{20}$$

so that while each agent pays less for screening than with a non-discriminatory policy, the number of terrorists who remain undetected is smaller. All agents are better off than with non-discriminatory screening.

3.5 Two types of agents; aversion to discrimination

Suppose that we have the same set-up as in 3.2, but agents are averse to a discriminatory screening policy, so that the presence of such a policy costs all agents utility c. Further, as in 3.4, non-screened travellers compensate screened travellers, so that all agents are equally well off. The marginal passenger now satisfies

$$u^* = e^{\alpha\epsilon/2s}(d + s + c) - d, \tag{21}$$

total welfare

$$W = \frac{1}{2}e^{-\alpha\epsilon/2s}[1 + d - e^{\alpha\epsilon/2s}(d + s + c)]^2, \tag{22}$$

and the optimal degree of screening solves

$$\frac{1}{2}e^{-\alpha\epsilon/2s}(\frac{\alpha\epsilon}{2s^2})[1 + d] + \frac{1}{2}(\frac{\alpha\epsilon}{2s^2})[d + s + c] - 1 = 0, \tag{23}$$

or, under (8),

$$s^{***} = \frac{\alpha\epsilon + \sqrt{\alpha^2\epsilon^2 + 16\alpha\epsilon(1 + 2d + c)}}{8}. \tag{24}$$

Welfare is now given by

$$W(I)^{***} = \frac{1}{2}[1 - s^{***}]^2; \quad W(II)^{***} = \frac{1}{2}[1 - s^{***}]^2. \tag{25}$$

Once again, this is an equitable outcome in that both types of agents enjoy the same level of welfare. Comparing (25) with the non-discriminatory screening policy in 3.2,

$$W^{***} > W^* \iff c < \frac{1}{4}[\alpha\epsilon + 4(1 + 2d) + \sqrt{\alpha^2\epsilon^2 + 8\alpha\epsilon(1 + 2d)}]. \tag{26}$$

That is, the greater is the risk of terrorism (α), the difficulty in detecting a terrorist for a given level of screening (ϵ), or the value of life (d), the larger must be the disutility associated with a discriminatory screening policy for a non-discriminatory screening policy to be pareto optimal. Under this scenario, a significant rise in the risk of terrorism may imply that the optimal screening regime switches from being non-discriminatory to being discriminatory.

3.6 Two types of agents; discrimination stigma

Suppose that we have the same set-up as in 3.2, but there is a stigma associated with being discriminated against, represented by a cost g that is borne by the group that is screened. Then a pareto improvement over the non-discriminatory policy would necessarily require that type II agents compensate type I agents. Suppose that, as in 3.4 and 3.5 above, the compensation is sufficient to ensure that both types of agents are equally well off, so that $s(II) = s(I) + g$ and $P(I) = P(II)$ under approximation (8). Then

$$\bar{s}(I) = 2s(II) - g \tag{27}$$

is the total screening revenue per type I traveller. The marginal passenger of each type now satisfies

$$u^* = e^{\alpha\epsilon/\bar{s}(I)}(d + \frac{1}{2}\{\bar{s}[I] + g\}) - d, \tag{28}$$

total welfare

$$W = \frac{1}{2}e^{-\alpha\epsilon/\bar{s}(I)}[1 + d - e^{\alpha\epsilon/\bar{s}(I)}(d + \frac{1}{2}\{\bar{s}[I] + g\})]^2, \tag{29}$$

and the optimal degree of screening solves

$$\frac{1}{2}e^{-\alpha\epsilon/\bar{s}(I)}\Big(\frac{\alpha\epsilon}{\bar{s}(I)^2}\Big)[1 + d] + \frac{1}{2}\Big(\frac{\alpha\epsilon}{\bar{s}(I)^2}\Big)[d + \frac{1}{2}\{\bar{s}[I] + g\}] - 1 = 0, \tag{30}$$

or under approximation (8),

$$\bar{s}(I)^* = \frac{\alpha\epsilon + \sqrt{\alpha^2\epsilon^2 + 16\alpha\epsilon(2[1 + 2d] + g)}}{8},$$

$$s(II)^* = \frac{1}{2}(\bar{s}(I) + g). \tag{31}$$

Consider the case where $g = s^*$ in (9). Then the welfare resulting from a discriminatory policy is identical to the non-discriminatory case. More generally, since $dW/dg < 0$, a discriminatory policy dominates a non-discriminatory policy if $g < s^*$. Then it is possible for Type II agents to fully compensate type I agents for their stigma, while still paying less than the cost of their own screening if screening is non-discriminatory. From (9) it is also straight forward to verify that the greater is the risk of terrorism (α), the difficulty in detecting a terrorist for a given cost of screening (ϵ), or the value of life (d), the larger must be the stigma associated with a discriminatory screening policy for a non-discriminatory screening policy to be pareto optimal. Again, a significant rise in the risk of terrorism may imply that the optimal screening regime switches from being non-discriminatory to being discriminatory.

3.7 Two types of agents; deceptive terrorists

One characteristic of many recent attacks in Israel is that terrorists have disguised their appearance in order to blend in with the local population. The simplest way of thinking about this in the current model is that ϵ, the difficulty of being detected, is changing over time. In the limit, as $\epsilon \to s$, terrorists can no longer be detected by screening at all. Note, however, that if s is chosen optimally by a policy maker, then for any value of ϵ, optimal s will entail $s > \epsilon$, as illustrated in Figure 1 for non-discriminatory (3.2) and discriminatory (3.4) screening (for parameter values to be outlined in Section 4). Figure 2 plots the corresponding welfare, and shows that over the relevant range, welfare under discriminatory screening dominates that under non-discriminatory screening. For $\epsilon > 0.24$, all agents cease to fly with non-discriminatory screening, while the critical cut-off occurs with much greater difficulty of detection ($\epsilon > 0.49$) with discriminatory screening.

Figure 1 and Figure 2 about here

Yet in reality ϵ is not exogenous, but likely represents a trade-off chosen by terrorist organisations. For example, if only terrorists that have a very low probability of being detected by screening were sent, then there would likely be only a small proportion of the population who may act as terrorists. Or alternatively, if there were additional costs in carrying out an attack with a reduced likelihood of being detected, then a terrorist organisation with finite resources will trade-off the quantity of attacks with the probability of success of each one.

In either case, the optimal choice of screening difficulty represents a trade-off between

α and ϵ for the terrorist organisation. In the current framework, the probability that a member of the Type I population will carry out a successful attack is $\alpha\epsilon/s$. Given the form of the optimal screening probability (equations (9), (18), (24), and (31) for each of the cases above, respectively), it is straightforward to show that terrorist organisations always wish to maximise $\alpha\epsilon$, subject to whatever constraints they face. In this model, the choice of screening regime has no impact on the decision by terrorists to try to increase the difficulty of being detected, assuming that the screening level is optimally chosen.

One could alternatively model deceptive terrorists as type I agents taking on the appearance of type II agents at some cost. Then discriminatory screening could be counterproductive (as in Sandler and Lapan 1988), by inducing terrorists to masquerade as the other type of agent and thereby avoid screening. The exact outcome would depend on how the constraints of the terrorist organisation are modelled (which are left unmodelled in the current paper), the functional forms, and also the parameter values assumed. We leave investigating this in more detail for future work.

4. NUMERICAL EXAMPLES

To illustrate these results, numerical examples that relax approximation (8) are contained in Table 1. Two values of α (the proportion of terrorists among type I agents) are considered, $\alpha \in (0.001, 0.01)$, for $d = 100$, and $\epsilon = 0.05$. First note that as the proportion of terrorists increase (from $\alpha = 0.001$ to $\alpha = 0.01$), the optimal amount of screening (s) increases, while the proportion of agents travelling ($1 - u^*$) and the welfare of travellers of both types (W) decreases. Moving from the non-discriminatory policy, pareto improvement I (no longer screening type II agents) increases the welfare of type II

agents, but does not change the welfare of type I agents. In contrast, pareto improvement II increases the welfare of all agents who choose to travel, and is equitable in the sense that travellers of a given u enjoy the same amount of welfare, regardless of their type. Finally, the maximum aversion to discrimination ($\bar{c}$) or stigma from discrimination ($\bar{g}$) that is consistent with a discriminatory policy pareto dominating the non-discriminatory policy is indicated. As the terrorist threat (α) increases, a larger aversion to or stigma from discrimination is requires for a non-discriminatory screening policy to be pareto optimal.

Table 1 here

5. CONCLUSIONS

Recent world events have prompted public debate about the desirability of discriminatory screening, including racial profiling, as a means to safeguard against terrorism. This paper has outlined an argument for why this may pareto-dominate screening that ignores observable characteristics, even if agents are risk neutral, casting the debate as a trade-off between efficiency and equity. The introduction of risk aversion would strengthen the results still further. In cases of risk from suicidal terrorists, a discriminatory screening policy, together with compensation for those inconvenienced by it, may pareto-dominate the official status quo.

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Table 1. Numerical Results.

α	Type	s	u^*	W	$\bar{c}$	$\bar{g}$
			Politically Correct Policy			
0.001	I/II	0.0709	0.1415	0.3683		
0.01	I/II	0.2242	0.4480	0.1520		
			Pareto Improvement (I)			
0.001	I	0.0709	0.1415	0.3683		
	II	0.0000	0.0706	0.4316		
0.01	I	0.2242	0.4480	0.1520		
	II	0.0000	0.1117	0.3010		
			Pareto Improvement (II)			
0.001	I/II	0.0501	0.1000	0.4048		
0.01	I/II	0.1585	0.3166	0.2331		
			Aversion to Discrimination			
0.001	I	0.0501	0.1415	0.3683	0.0415	
	II	0.0000	0.1415	0.3683	0.0415	
0.01	I	0.1586	0.4480	0.1520	0.1313	
	II	0.0000	0.4480	0.1520	0.1313	
			Discrimination Stigma			
0.001	I	0.0709	0.1415	0.3683		0.0709
	II	0.0000	0.1415	0.3683		
0.01	I	0.2242	0.4480	0.1520		0.2242
	II	0.0000	0.4480	0.1520		

Key:	s	optimal level of screening
	u^*	marginal traveler (a low u^* implies more persons travel)
	W	welfare
	$\bar{c}$	maximum aversion to discrimination for discriminatory policy to dominate politically correct policy
	$\bar{g}$	maximum stigma from discrimination for discriminatory policy to dominate politically correct policy

Figure 1. Optimal Screening Cost

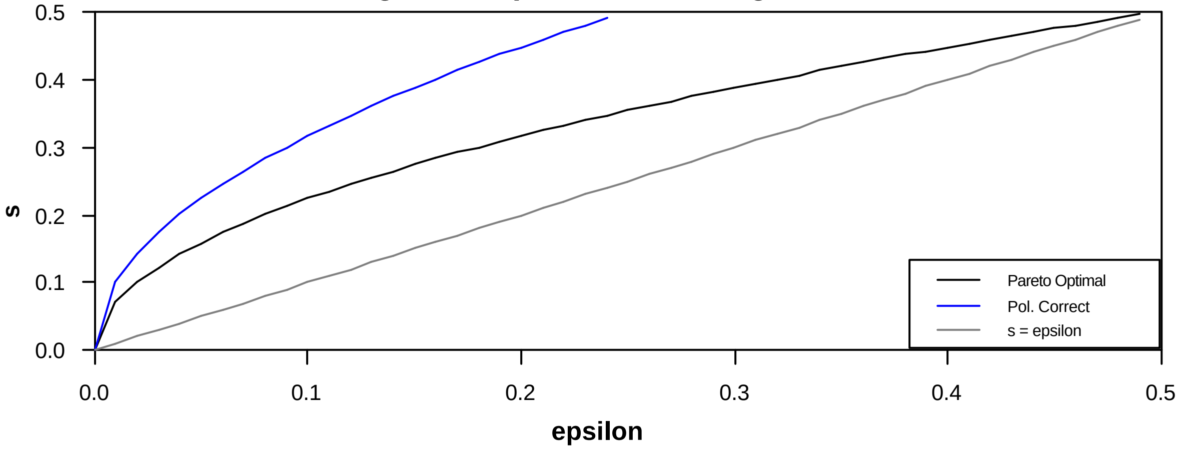

Figure 2. Welfare