THE 'PRICE' OF TERRORISM

Security measures are said to increase the price of terrorism. This price has not hitherto been defined in an economically meaningful way. This paper provides a precise definition by treating the terrorists' resource endowment as a parcel of contingent claims to political influence with a price equal to the summed value of those contingent claims in potential states of the world. Equipped with this definition, an equilibrium model of the price of terrorism is constructed. Important insights are gained into the effect of terrorists' risk aversion on the level of the price of terrorism in different states of the world and the theoretical conclusion is reached that higher security is associated with a lower price of terrorism rather than a higher price. The implications for policy are discussed.

Key Words: Terrorism, price of terrorism, resource endowment, contingent claims, political influence.

1   INTRODUCTION

The effect of higher security on terrorist behaviour is a matter of considerable importance, not only to the governments who must set the policy but also to the citizens of the world who wish to live in democratic freedom and peace. Some important questions have emerged over the past two decades as economists began to devote more attention to the application of economic analysis to terrorism. Specifically, does higher security increase the price of terrorism? Is the reverse true? What is nature of the price of terrorism? Although these questions have been an implicit subject in many studies and investigations over the past two decades, they remain largely unanswered. This is due to the absence in the economics of terrorism literature of a complete and rigorous statement of what exactly constitutes the price of terrorism. This paper will attempt to fill this gap in the theoretical economics of terrorism literature.

This paper is organised as follows. Section 2 is a discussion of the basic features of economic analyses of terrorism. This discussion focuses on the application of subjective

expected utility theory to terrorism and the interpretation that enhanced security measures increase the 'price' of terrorism. Section 3 presents a precise definition of the price of terrorism. Section 4 contains the theoretical analysis. I show that under certain assumptions, conclusions can be reached about the levels of these prices in different states of a non-deterministic world. In Section 5, the various implications of the model are discussed. This is followed, in Section 6, by suggestions for future research and conclusions.

2   BASIC FEATURES OF ECONOMIC MODELS OF TERRORISM

The evolution of the economics of terrorism literature as an excrescence of the economics of defence literature is notable for its overwhelming focus on the application of subjective expected utility (SEU) theory to terrorist behaviour: Terrorism is the outcome of utility maximising behaviour and the decision to undertake a terrorist activity is a choice-theoretic decision.

Typically, economic models of terrorism contain the following features:

(1) Terrorists optimise explicit objective functions, subject to the resource and technology constraints that they face;

(2) Terrorists derive utility from the political influence that they secure in a successful terrorist attack;

(3) The outcome of an attack is a stochastic variable.

(4) Terrorists are risk averse. They dislike any enhanced possibility of divergence of actual outcomes from expected outcomes; and

(5) The increase or decrease in the terrorists' stock of political influence following an attack is often represented by monetary or wealth equivalents in the terrorist's objective function.

A simple generic SEU model of terrorism is easy to construct. Such choice-theoretic models underlie most economic analyses of terrorism.

Consider a representative terroristic agent. The agent's preferences are described by a conventional function that relates utility to the political influence that is expected from a terrorist attack:

$$U_t = E \sum_z u(z)\pi(z)$$

(1)

Here E is an expectations operator, $u(z)$ is a utility function and $\pi(z)$ is the subjective probability of an outcome. In this model, z denotes the political influence that the terrorist procures from a particular attack. Equation (1) relates the terrorist's utility to his or her expectation of the amount of political influence to be derived from an attack. Political influence could be represented by a monetary equivalent so that a dollar amount rather than 'units of political influence' represents the payoff from an attack but the conclusions would be same. In addition to the utility function, the economic analysis of terrorism requires hypotheses explaining the effect of enhanced security on the utility of the terroristic agent. Usually the behaviour of the terrorist is analysed under two such hypotheses: first, government policies that decrease z negatively impact the terrorist's utility; and second, government policies that increase the probability of an undesirable outcome decrease the terrorist's utility.

Policies that might decrease the political influence that the terrorist procures from an attack include: (1) denying terrorist groups recognition for their actions (Frey, 1988); (2) decentralising the polity and the economy (Frey and Luechinger, 2003); and (3) never negotiating with terrorist groups (Sandler, Tschirhart and Cauley (1983) and Lapan and Sandler (1988))[1]. Some of these ideas have received more attention in recent times. During the spate of kidnappings of foreign workers in Iraq in 2003 and 2004, many governments reaffirmed their commitment to never negotiate with terrorists. Also in 2004, in light of possible attacks against landmark facilities such as the New York Stock Exchange, officials were quick to state that such an attack would not do critical damage to the functioning of markets or the financial system because trading could be diverted

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[1] Also see Frey and Luechinger (2003). These authors present a valuable discussion of all of these issues.

through the regional exchange facilities. This is an example of decentralization. Making it well known that an attack on one facility would have little impact on the functioning of the system could certainly be expected to reduce the expected utility of an attack on that facility.

Policies that might increase the probability of an undesirable outcome for the terrorist include: (1) enhanced security; and (2) harsher penalties. For example, Landes (1978), in an oft-cited study[2], investigated the factors that might play a part in determining whether a terrorist undertakes a hijacking. Utilizing a model with three possible stochastic outcomes (success, apprehension with no conviction and apprehension with conviction), Landes argued that the potential hijacker decides to hijack when the expected utility associated with the hijacking exceeds the expected utility of not undertaking the hijacking. According to Landes' model, important considerations for the terrorist in making this decision include his or her estimate of the probability of apprehension and his or her estimate of the conditional probability of conviction if apprehended. Security measures such as metal detectors that may increase the probability of apprehension and tough government policies on the prosecution of offenders that increase the probability of conviction if captured should go some way towards deterring hijackings, if the theoretical reasoning is correct.

Empirically, there is some evidence to support the theoretical conclusion that terrorist attacks are deterred by enhanced security. For example, there appears to be a negative relationship between incidences of hijackings and the installation of metal detectors at airports (Landes, 1978). However, security mechanisms that are specifically targeted at preventing one sort of attack are likely to be weak at reducing the overall incidence of terrorism. There is a strong substitution effect that must be taken into account. Terrorists will tend to switch from the now more difficult attacks to other forms of attacks. In a recent empirical study, Enders and Sandler (2002) found that piecemeal policy is indeed ineffective at reducing overall levels of terrorism. The authors reported, "...Efforts to secure U.S. airports and borders will cause terrorists to stage their attacks against

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[2] See, for example, Sandler and Hartley (1995) and Frey and Luechinger (2003).

Americans at other venues and in other countries" and, "...The installation of metal detectors in airports cut down on skyjackings but was associated with an increase in other hostage-taking events" (Enders and Sandler, 2002, p.162). This points to a general difficulty facing governments seeking to reduce the number of terrorist attacks carried out against its citizens.

What is important from the point of view of this paper is the way in which the predictions of SEU theory and the empirical results have been interpreted. In expositions or reports of the findings outlined above, some authors have explained the apparent success of enhanced security as being due to the increase in the 'price' of terrorism that is a consequence of enhanced security. For example, Enders and Sandler (2002, p.162) spoke of terrorists responding to "higher prices" stemming from a policy intervention such as metal detectors at airports and suggested that to raise the "price" of all types of terrorist attacks would require enhanced security throughout society. But what does it really mean to say that enhanced security increases the price of terrorism? Does it mean that terrorism is more expensive? Or does the terrorist pay a greater price for failure? Or does it mean that the terrorist has to spend more time and effort planning ways to circumvent security measures? The price of terrorism has not been clearly defined in a way that has discernible economic meaning. This means that one cannot speak unequivocally about the impact of enhanced security measures on the 'price' of terrorism, a situation that is inconvenient for the economist accustomed to speaking of, and thinking in terms of, prices. The price of terrorism requires a definition.

3 THE PRICE OF TERRORISM DEFINED

Most economic analyses of terrorism have, as mentioned above, assumed that the terrorist's utility is a function of the political influence that he or she derives from a terrorist attack. Political influence is a good. It is a good because the terrorist wants it but it costs something to procure. The key to defining the price of terrorism is to determine what the terrorist gives in exchange for this good, political influence. Clearly, the terroristic agent gives all or part of a resource endowment in exchange for political

influence. These resources include money, time, weapons, explosives and human capital (suicide bombers, planners, strategists and coordinators). It is the terrorist's resources that permit the terrorist to procure political influence. The terrorist's resource endowment has a value to the terrorist for this reason. Once this is recognized, one is led directly to a precise economic definition of the price of terrorism.

The terrorist wants political influence. The resources that the terrorist possesses permit the terrorist to procure political influence. Without his resources the terrorist is unable to obtain political influence. The resource endowment may be thought of as an asset. It can be used in a terrorist attack (sold) either now or later. The resource endowment permits the terrorist to obtain political influence across time. In addition, the resource endowment provides the terrorist with a contingency against possible conditions that may be faced in the next period. If the terrorist expects it to become very difficult to procure political influence in the future, the resource endowment that he possesses provides him with some assurance that he will still be able to procure political influence in the future by deploying his resources in terrorist attacks. The terrorist's resource endowment is an asset that represents claims on political influence in potential states of the world. Such an asset is called a contingent claim.

Imagine a simple economic system where terroristic agents attempt to maximize their utility by absorbing political influence[3]. The economic system may occupy either a low security state or a high security state. From the point of view of the terrorist, the low security state is good and the high security state is bad. Terroristic agents have a resource endowment, the components of which are contingent claims on political influence in potential states of the world. These contingent claims are assets that permit their holder to procure political influence. These assets may be deployed (sold) at any time and the proceeds (political influence) absorbed. At each period, the price of a component of the terrorist's resource endowment will equal the summed value of the contingent claims to political influence that the asset represents, measured in units of political influence[4] at the

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[3] This will be made more precise below.
[4] Or a monetary equivalent.

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assumed state and date (see LeRoy and LaCivita, 1981, p.538). That is, each component of the terroristic agent's resource endowment has a price that is equal to the amount of political influence it permits the agent to procure in potential states of the world. The terrorist will not 'sell' for less. This is the price of terrorism.

This definition of the price of terrorism is advantageous for one important reason. It permits the deployment of equilibrium asset pricing theory in the analysis of terrorism. Whenever linkages between theoretical frameworks are made, either within a discipline or between disciplines, new insights can be generated. The terrorists' resources are assets. The resources are assets that permit the procurement of a good, political influence. The terrorists' resources are assets that are claims to political influence. Once this analogy between assets and resources is recognized, one can state that an economically meaningful definition of the price of terrorism is the summed value of the contingent claims to political influence that the terrorists' resources represent, measured in units of political influence at the assumed state and date.

Having defined the price of terrorism as such, two questions present themselves. Specifically, when will these prices be high and when will they be low? What factors might be important in causing the price of terrorism to vary through time? These questions are answered in the theoretical analysis contained in the next section where a recursive equilibrium model and economic logic are utilized to show that (1) the price of terrorism as defined above will be higher when the system is in the low security state and lower when the system is in the high security state; and (2) the price of terrorism will be more variable the more averse to risk terroristic agents happen to be.

4   THEORETICAL ANALYSIS

This theoretical analysis takes place within an economic setting where there is only one good, political influence. The terroristic agents in this economy attempt to maximize utility by absorbing this good. Terroristic agents possess a resource endowment. Each component of the terrorist's resource endowment is a contingent claim to political

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influence. The economic system may either be in a low security state or a high security state. In the low security state the terroristic agent can obtain political influence easily. In the high security state, the terroristic agent finds it difficult to obtain political influence. The terrorist's marginal utility with regard to political influence will therefore be different in the different states of the world and consequently, as a parcel of contingent claims, the terroristic agent's resource endowment will be valued differently in different states of the world. This means that the equilibrium price of terrorism in this theoretical economy will vary through time, being relatively high sometimes and low at other times. The first part of this theoretical analysis has as its objective to determine the relationship between the stochastic evolutions of the economic system from state to state and the price of terrorism as defined in this paper.

Assume that a single (risk averse) terroristic agent inhabits this economic system. He is representative of a large number of identical agents. The terroristic agent wishes to maximize a (additive) utility function of the form

$$EU(w_t) = E[\sum_{t=0}^{\infty} \rho^t U(w_t)] \tag{2}$$

Where w_t is a stochastic process representing the absorption of the single good in this exchange economy (political influence) at date t, $U(\cdot)$ is a period t utility function, ρ is a discount factor and E is an expectations operator. The terroristic agent's objective is to maximize his absorption of political influence over the decision-making horizon.

At each period this economic system occupies a state. Let the set of possible system states be denoted by S. Assume that S is discrete (finite) and that there are only two possible states of the world: a high security state (h) and a low security state (l). At every period, the system is in state $s \in S$. If S = {h, l} then it is clear that s must either be h or l. The probability of each state occurring in the next period depends only on the immediate history of the system and the next state of the world is stochastic. A system where the probability of each state occurring in the next period depends only on the immediate

history of the system is Markov. The transition probability $pr(h|l)$ is the probability that if the system is in the low security state at a particular observation, it will be in the high security state at the next observation. The probabilities must all lie between 0 and 1. For any fixed state, h or l, it must be the case that

$$pr(l|h) + pr(h|h) = 1$$

(3)

$$pr(h|l) + pr(l|l) = 1$$

This means that if the system is in either state at time t, it will certainly be in one of the two states at $t + 1$. Equations (3) are the transition probabilities of the system.

The terroristic agent begins each period with a resource endowment $q_t = (q_{1t}, q_{2t}, ..., q_{nt})$. Each unit of q is a contingent claim that permits its holder to obtain some of the single good in this economy, political influence. The price of terrorism at each date is described by a price vector $p_t = (p_l, p_h)$ where p_l is the price of terrorism in the low security state and p_h is the price of terrorism in the high security state. Recall that the price of terrorism is equal to the summed value of the claims to political influence in potential states of the world that the terrorist's resources represent, measured in units of political influence at the assumed state and date. The model is a recursive equilibrium model because the terrorist's behaviour determines the prices and the prices determine the terrorist's behaviour.

The terroristic agent may 'sell' an asset at any time and realize $p_t = (p_l, p_h)$. The way in which the terroristic agent 'sells' an asset is by deploying a component of his resource endowment in an act of terrorism. The proceeds, p_t, from the 'sale' are political influence, which is absorbed by the terroristic agent. There is no facility to re-obtain a component of the resource endowment once it has been sold. The terroristic agent cannot increase his utility by deploying a component of his resource endowment in the current period and subsequently re-obtaining it in a later period. Any increase in utility in the current period

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resulting from the deployment of a component of the resource endowment must be equal to a decrease in utility in the next period. Under such conditions one can speak meaningfully about the equilibrium prices.

The terroristic agent starts with $q_t = (q_{1t}, q_{2t}, ..., q_{nt})$. Any deployment (sale) of a component of q_t in a terrorist attack at time t increases the terroristic agent's utility by $p_t MU_t^w$, where MU_t^w is the terroristic agent's marginal utility of the absorption of political influence. As mentioned above, any increase in utility in the current period resulting from a deployment of resources in a terrorist attack must be offset by an equal decrease in utility in the next period, since there is no facility to re-obtain a component of the resource endowment once it has been deployed. Hence,

$$p_t MU_t^w = \rho E(\tilde{w} + \tilde{p}) \tilde{MU}^w \qquad (3)$$

And the price of terrorism in each state of the world will be given by two rather straightforward equations (which are adaptations of LeRoy and LaCivta's[5] (1981) asset pricing equations). These equations are presented below:

$$p_l MU_w^l = \rho[(p_l + \overline{w}_l)pr(l \mid l)MU_w^l + (p_h + \overline{w}_h)pr(h \mid l)MU_w^h]$$

$$\qquad (4)$$

$$p_h MU_w^h = \rho[(p_l + \overline{w}_l)pr(l \mid h)MU_w^l + (p_h + \overline{w}_h)pr(h \mid h)MU_w^h]$$

In these equations (4), p_h denotes the price of terrorism in the high security state of the world; p_l denotes the price of terrorism in the low security state of the world; and $\overline{w}_l$ is the terrorist's stock of political influence in the less secure state of the world ($> \overline{w}_h$). As expected from the comments made previously about the terroristic agent's valuation of

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[5] The reader will see that much of the following analysis is an adaptation of LeRoy and LaCivita's equations to the new scenario of theoretical economics of terrorism. Analogy, however, is a powerful ally in the development of new insights.

his resource endowment as a parcel of contingent claims to political influence, the price in each state of the world depends upon the terroristic agent's marginal utility of political influence absorption, the transition probabilities that determine the potential states of the world and the terroristic agent's level of political influence at that state. Importantly, in the low security state of the world, the price of terrorism depends, in part, upon the terrorist's marginal utility for political influence absorption in the high security state of the world. Likewise, in the high security state of the world, the price of terrorism depends, in part, upon the terrorist's marginal utility for political influence absorption in the low security state of the world. This is shown more clearly in equations (5) below.

$$p_l = \rho[(p_l + \overline{w}_l)pr(l \mid l) + (p_h + \overline{w}_h)pr(h \mid l)MU_w^{h}]$$

$$(5)$$

$$p_h = \rho[(p_l + \overline{w}_l)pr(l \mid h)MU_w^{l} + (p_h + \overline{w}_h)pr(h \mid h)]$$

The price of terrorism within this economic system will exhibit ebbs and flows. As the system moves from state to state (from high to low, low to high, high to high or low to low), the risk averse terrorist will continuously attempt to optimize the objective function assigned to him above. This will mean making decisions about when to deploy a component of his resource endowment in a terrorist attack. The terrorist's decisions determine the prices and the prices determine the terrorist's decisions. This is the essence of a recursive equilibrium model. As long as the terroristic agent is acting optimally, revising his decisions from time to time, it would be expected that the price of terrorism over time would tend to be relatively high in the low security state of the world and that the price of terrorism would tend to be relatively low in the high security state of the world. This is explained further in the next paragraph.

Conclusions about the relative level of the price of terrorism in either state of the world follow logically from the economic configuration outlined above. The price of terrorism as the summed value of the contingent claims to political influence that the terrorist's resources represent, measured in units of political influence at the assumed state and date,

will be high in the low security state and low in the high security state. In the low security state, political influence is relatively easy to obtain. In the high security state, political influence is more difficult to obtain. In the low security state the price of terrorism will be high because the terroristic agent will value the components of his resource endowment more highly as contingent claims against the possibility that tomorrow could be characterized by high security, a state of the world where political influence is difficult to procure. Conversely, in the high security state of the world, immediate procurement of political influence is more important than a contingency against the possibility that tomorrow could be characterized by low security. Hence, in the high security state of the world, the terroristic agent values the components of his resource endowment less than he does in the low security state of the world. The price of terrorism will be lower in the high security state of the world. This completes the first part of this analysis.

The risk aversion of terroristic agents is a variable of great importance to this analysis and theoretical economics of terrorism. Risk aversion is implicitly assumed in SEU analyses of terrorist behaviour when it is argued that increased probability of apprehension or greater divergence of actual outcomes from expected outcomes decreases the terrorist's expected utility. In the analysis presented in this paper, it is the risk aversion of the terroristic agent that contributes to the different valuations of the resource endowment in different states of the world. The behaviour described above is extenuated when the terroristic agent in our simple economic setting exhibits greater degrees of risk aversion. The second part of this theoretical analysis has as its objective to state objectively the relationship between the risk aversion exhibited by the terroristic agent and the degree of variability in the price of terrorism in the different states of the theoretical exchange economy whose configuration was outlined above. In the second part of this analysis, it is shown that the high price of terrorism in the low security state will be higher and low price in the high security state will be lower, the more risk averse the terroristic agents happen to be.

Assume, as before, a simple economic setting in which a representative terroristic agent attempts to maximize utility by absorbing political influence over a decision horizon. If

one unit of the terroristic agent's resource endowment is deployed at time t and the gains added to w_t, then utility increases by $p_t MU_t^w$ where p_t is the 'price' received in exchange for the unit of resources and is equal to the summed value of all the contingent claims to political influence in potential states of the world, measured in units of w at the appropriate state and date. Now, the terroristic agent's ratio of the marginal utilities of political influence absorption in either state of the world is a measure of the agent's degree of risk aversion. Letting R denote this ratio and, therefore, the terroristic agent's degree of risk aversion, (again, using an adaptation of LeRoy and LaCivita's (1981) equations) we have

$$R = MU_w^h / MU_w^l = \overline{w}_h / \overline{w}_l \tag{6}$$

Expressing the prices in each state of the world as functions of risk aversion gives

$$p_h = \rho[(p_l + \overline{w}_l)pr(l \mid h)/R + (p_h + \overline{w}_h)pr(h \mid h)] \tag{7}$$

$$p_l = \rho[(p_l + \overline{w}_l)pr(l \mid l) + (p_h + \overline{w}_h)pr(h \mid l)R] \tag{8}$$

Solving for p_h and p_l then gives

$$p_h = \frac{\rho \overline{w}_l pr(l \mid h)/R + \rho \overline{w}_h[\rho \, pr(h \mid l) + pr(h \mid h)(1 - \rho)]}{(1 - \rho)\{1 + \rho - \rho[pr(l \mid l) + pr(h \mid h)]\}}$$

$$\tag{9}$$

$$p_l = \frac{\{\rho \overline{w}_l pr(l \mid l)(1 - \rho) + \rho[1 - pr(h \mid h)]\} + \rho \overline{w}_h[1 - pr(l \mid l)]R\}}{(1 - \rho)\{1 + \rho - \rho[pr(l \mid l) + pr(h \mid h)]\}}$$

These equations (9) permit the precise identification of the relationship that exists between the degree of risk aversion exhibited by the terroristic agent and the price of terrorism. In the low security state of the world, the price of terrorism increases with risk

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aversion in a linear fashion. In the high security state of the world, the price of terrorism decreases in a non-linear fashion as risk aversion increases. This is due entirely to the fact that a risk-averse agent is averse to the high security state of the world and the associated decline in political influence absorption. Such an agent values his resource endowment highly in the low security state and will not part with a component of it for anything other than a high price because he wishes to ensure that he may endure the possible high security state in the next period. The more risk-averse the representative terroristic agent, the higher will be the price of terrorism in the low security state and the lower will be the price of terrorism in the high security state. The more risk-averse the terroristic agent is, the more variable the price of terrorism will be through time. This clearly identifies the fact that risk aversion, an implicit component of standard SEU analyses of terrorist behavior, has important influence on the price of terrorism. This influence could not have been revealed without the application of equilibrium asset pricing techniques to terrorism. This application is the direct result of the economically meaningful definition of the price of terrorism presented for the first time in this paper. This completes the second part of the theoretical analysis.

To recapitulate, once the price of terrorism was defined in an economically meaningful way, questions about the levels of these prices (high or low) and the determinants of their variability were immediately evident. The preceding analysis generated answers to these questions through the application of an equilibrium asset-pricing model to the terrorists' resource endowment, where the resource endowment was implied to be analogous to a parcel of contingent claims permitting the terroristic agent to procure political influence in potential states of the world. The conclusions that may be drawn from the preceding analysis may be stated as follows:

(1) The price of terrorism will be *lower* in the *high* security state and *higher* in the *low* security state.

(2) The price of terrorism in the more secure state of the world decreases non-linearly with risk aversion.

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(3) The price of terrorism in the less secure state of the world increases linearly with risk aversion.

The implications of these theoretical results are discussed in the next section. Specifically, the implications for both theoretical economics of terrorism and government anti-terrorist policy measures are discussed.

5   IMPLICATIONS FOR THEORY AND POLICY

The treatment of the terrorist's resource endowment as a parcel of contingent claims to political influence in potential states of the world permits the precise definition of a price of terrorism. The definition presented in this paper has the particular advantage of opening up the analysis of terrorism and terrorist behaviour to the application of general equilibrium asset pricing theory. The application of general equilibrium asset pricing theory undertaken in this paper is an adaptation of work previously done by financial economists who had investigated the pricing of contingent claims on consumption. This adaptation yielded a number of results that could not have been generated using the standard SEU theoretical analyses usually deployed in the economics of terrorism literature. The analytical implications of these results are discussed in this section along with the implications of the results for policy.

The standard theoretical interpretation of SEU theory as it applies to terrorism is that increased security such as metal detectors at airports will increase the 'price' of terrorism. Armed with an appropriate definition, the analysis presented above showed that higher security is actually associated with a decrease in the price of terrorism as defined in this paper. This is because the terrorist's resource endowment is more valuable to the risk-averse terrorist when security is low and political influence is easy to obtain and less valuable when security is high. From an analytical standpoint, this result highlights the importance that definitions play in theoretical work. The price of terrorism has hitherto been rather a vague concept. The provision of a precise definition provides a sound basis

from which to proceed with analysis and, in this case, has permitted the generation of results that may be unequivocally stated.

Also analytically important is the relationship between the price of terrorism and risk aversion. Risk aversion on the part of terrorists is treated only implicitly in standard SEU studies. However, since risk aversion plays an important role in so many other economic analyses it would be unusual not to find a place for it in the theoretical economics of terrorism literature. This analysis has revealed it to be a concept of considerable import for the economics of terrorism. The preceding analysis showed that, in the less secure state of the world, the price of terrorism increases linearly as the terrorists' risk aversion increases. In the more secure state of the world, the price of terrorism decreases non-linearly with risk aversion. This relationship is important because, if terrorists are indeed risk averse, they are more sensitive to certain aspects of their environment (in this case, higher or lower security). If governments could find a way to increase terrorists' risk aversion, terrorists would be more sensitive to enhanced security and the price of terrorism would fall more substantially when security measures are enhanced. This adds a certain degree of rigor to a relationship that has only been implicitly expounded in the economics of terrorism literature.

The theoretical analysis presented in the preceding section also has implications for policy. Specifically, it implies that higher security will tend to lower the price of terrorism. At first this may seem like particularly bad news for policy-makers. After all, security enhancements have been a major part of governments' anti-terrorism measures. Fortunately, however, a lower price of terrorism is actually a good thing. A lower price of terrorism corresponds to the terrorist's resource endowment having a lower value. When the world is characterized by higher security, the terrorist's resource endowment is less valuable and will be exchanged for less political influence. This is obviously desirable. In light of this theoretical conclusion, governments should seek to decrease the price of terrorism as defined in this paper, not increase it. Fortunately, many of the policies that governments have already put into practice could be expected to decrease the price of terrorism.

Government imposed security enhancements such as higher security at airports will decrease the price of terrorism by decreasing the value of those particular components of the terrorist's resource endowment that are principally suited to airport or aircraft terrorism. The standard conclusion in the theoretical economics of terrorism literature is that the negative impact on the terroristic agent of these focused security measures is negligible because the terrorist simply substitutes away from aircraft terrorism. The theoretical analysis presented above, however, only partially supports such a conclusion. By clearly identifying the terrorist's resources as a parcel (q_t), the value of which is equal to its summed value of contingent claims to political influence in potential states of the world, it is more precise to conclude that the negative impact on the terrorist will only be zero to the extent that his resources are perfectly substitutable. Even if just one component of the terrorist's resource endowment is suited only for aircraft terrorism, an increase in airport security will decrease the value of his resource endowment. From the viewpoint of government policy-makers, this is a good thing. Unless terrorist's resources are completely and perfectly substitutable, this theoretical lends support to any enhancements in security.

A lower price of terrorism is desirable. Security enhancements will reduce the price of terrorism. The question arises as to what characteristics the economist might expect to see exhibited by the time series of terrorist attacks if the theoretical analysis and reasoning presented above is accurate. Proceeding purely on the basis of economic logic, it would seem plausible to suggest that if security enhancements are associated with a decrease in the value of the terrorist's resource endowment, the economist should expect to see a decline in the level of devastation (measured perhaps in terms of lives lost or economic damage sustained) associated with each terrorist attack following enhanced security. The terroristic agent places a lower value on his resource endowment when security is high. He will therefore be willing to exchange a component of his resource endowment for a smaller amount of political influence when security is high. This implies smaller-scale attacks, which, in turn, implies relatively less devastation.

Empirical studies (for example, Enders and Sandler (2002)) have found that there are sometimes more terrorist attacks following security enhancements. The theoretical analysis presented above implies that the number of terrorist attacks is not the important variable to examine. Rather, economists should be interested in the scale or devastation of the terrorist attacks following enhanced security. Enhanced security may not decrease the number of attacks but only the devastation caused by them. Also, as Enders and Sandler (2002) found, enhanced security at home may be associated with increased attacks abroad. This is consistent with the theoretical analysis presented in this paper. Attacks in other countries are lower priced events *vis-à-vis* attacks on US soil and the theoretical analysis presented herein implies that enhanced security will indeed lower the price of terrorism. At least, this is what could be expected on average. There may be exceptions to this predicted pattern for the reasons outlined below.

The prices p_l and p_h are equilibrium prices that are expected to prevail in the economic system whose configuration was outlined above. Even within this precisely defined system, the stability of the equilibrium cannot be taken for granted. However, the prices should tend towards the behavior described by the model over time as long as terroristic agents hold consistent preferences for absorption of political influence and resource holdings. One reason for intermittent departures from a stable equilibrium could be that the terroristic agents are unaware of the probability distribution governing the transition of the system from state to state. Under such circumstances, the system may be unstable as the terroristic agents learn the characteristics of the aforementioned distribution. Supposing that government policy is somehow linked to the transition of the system from one state to another, the terrorist's reactions to government policies may not be entirely as expected if the terroristic agents must learn the characteristics of the distribution of the government's policy decisions. One could plausibly suggest, therefore, that relative instability might characterize the price of terrorism in a system where the government favored discretion over policy rules. It is difficult to say whether this might be favorable or unfavorable from the government's point of view. One thing is certain, however, the only feasible way to maintain a low price of terrorism is through a perpetual maintenance of high security.

6   CONCLUSIONS AND FUTURE RESEARCH

This paper has presented a formal definition of the price of terrorism that has economic content and has set out a model of the price of terrorism in a two-state non-deterministic world. The model is characterized by properties normally possessed by the pricing models deployed by financial economists. Its pricing equations are simply an adaptation of a recursive equilibrium type model developed by LeRoy and LaCivita (1981) and based on earlier work by LeRoy (1973) and Lucas (1978). The model differs substantially, however, from standard economic models of terrorism. The result of this difference was to produce a model of the price of terrorism with the following implications:

(1) The price of terrorism will be *lower* in the *high* security state and *higher* in the *low* security state.

(2) The price of terrorism in the more secure state of the world decreases non-linearly with risk aversion.

(3) The price of terrorism in the less secure state of the world increases linearly with risk aversion.

The model described in this paper does not lend unconditional support to the conclusion that higher security has only negligible effects on the terrorist because he or she simply substitutes one type of attack for another. By clearly defining the price of terrorism and by clearly identifying the terrorist's resources as a parcel of assets, this theoretical analysis implies that any security measure must in some way affect the overall level of terrorism because any enhancement of security reduces the value of the terrorist's resource endowment. The only exception would be where every component of the terrorist's resource endowment is completely substitutable from one type of attack to another. This theoretical analysis supports enhancements in security measures undertaken

by the government. The theoretical analysis presented herein was just one possible analysis that could have been undertaken. Expanding the analysis to a more dynamic model with a continuum of potential states of the world (as deployed by Lucas (1978) or by modern asset pricing theorists) would be an interesting task for future research as would more intensive investigation of the importance of terrorist's risk aversion for both theory and policy.

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