Social Welfare and the Benefits to Crime

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Abstract

There exists a large literature on the optimal deterrence of crime. Within the literature, however, there exists a controversy over what the appropriate criterion to determine optimality should be. While the most popular method is that of maximization of a utilitarian welfare function, another criterion sometimes used is that of cost minimization. The controversy stems from the question of whether the benefits to crime enjoyed by criminals ought to be included in the welfare analysis. This paper argues that the controversy is an artifact of the fact that the standard model restricts a potential criminal's choice to one of committing a crime or doing nothing. We show that when potential criminals are given the additional choice of achieving their ends through voluntary methods that maximizing the sum of utilities is in fact equivalent to minimizing the costs of crime. The model developed also provides explanations for sanctions that increase in one's criminal history and why necessity may be a partial defense.

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1 Introduction

Every theoretical paper dealing with welfare in economies where crime is possible has to contend with a rather large elephant in the room: the benefits criminals derive from their illegal activities. Inclusion of such benefits in a welfare function is controversial as it seems distasteful that society might value the utility derived from rape. Exclusion is also controversial as it entails a judgement call about what sources of utility are valid - *de gustibus non disputandum est*.

This paper argues that the controversy stems from not from the Pareto principle but from the criminal's choice set. The standard model gives potential criminals the choice of committing a crime or doing nothing. In this paper we extend the standard model to allow potential criminals the possibility of achieving their ends through voluntary exchange. We demonstrate in the extended model that maximization of a utilitarian welfare function that includes the benefits derived from crime is equivalent to minimizing the social costs of crime (and therefore excluding those benefits) in a model in which criminals have the usual binary choice set. We further argue that the extended model is in fact the appropriate one for many crimes at the center of the controversy.

This controversy dates back to the nascent days of the literature. In Becker's (1968) seminal paper, he considered a metaphorical market for crime in which the supply of offenses was determined by the probability of apprehension and conviction and the sanction while 'demand' was determined by the net social harm (harm to victims less the benefits to criminals) caused by the activities - a measure of society's tolerance for crime. The assumption that the benefits derived from criminal activities should play a role in the analysis was instantly controversial. Stigler (1970) asked "what evidence is there that society sets a positive value on the utility derived from a murder, rape, or arson?" (p. 527) He further noted that the reason Becker included the gains to criminals was primarily to avoid the result that all punishments should be set maximally - the so-called 'Becker paradox'. Stigler proposed that the real reason we do not observe all maximal punishments for all crime was to achieve marginal deterrence. Since criminals may choose both the quantity and type of crimes to commit, maximal penalties across penalties across the board would lead to more harmful crimes and reduced deterrence beyond the first crime committed.

Despite Stigler's objections, the standard model used today entails the maximization of a utilitarian welfare function which includes the benefits to criminals, the harm to victims and the costs of enforcement, hereafter referred to as the Standard Utilitarian Welfare (SUW) model. The SUW model has been used extensively in the literature[1], sometimes with a disclaimer that the concept of efficient rape or hate crimes may be distasteful and unappealing (see Dharmalapala and Garoupa (2004), who examine hate crimes). One reason that it has become so widespread is that economists tend to adhere to the Pareto principal, and do not question the source of utility. Another reason that the SUW model has become so prevalent is that it is quite tractable and many of its implications are very intuitive. For example, the SUW model implies that punishments should be increasing in the social harm caused.

For many types of criminal behavior, however, it is possible for potential criminals to achieve their ends through legitimate, voluntary methods.[2] We examine an extension of the SUW model in which potential criminals have a third option, such as trade. For example, in the context of theft, the potential offender may obtain a good either by purchasing rather than stealing it. The Extended Utilitarian Welfare (EUW) framework shares many of the virtues of the SUW model, in that it does not question the source of utility and preserves the tractability of the SUW model as well as many of its appealing implications. However, in the EUW setting the maximization of a utilitarian social welfare function is equivalent to minimizing the costs of crime. This suggests that the controversy over the appropriate welfare criterion is an artifact of the choice to model criminal behavior as binary.

This has several important implications. First note that in the SUW model the optimal penalties are ones that induce "efficient crimes," i.e. ones for which the benefits to the criminals outweigh the social harm. Specifically, in the optimum,

[1]It is perhaps best exposited in Polinsky and Shavell (2000) and will be discussed on more detail below.

[2]We do not claim that every crime has a corresponding option for voluntary trade. However, it is also the case that the inclusion of criminal benefits is not controversial for all crimes. We hope to show that the crimes for which the inclusion of criminal benefits is controversial also tend to be crimes for which there exists a voluntary exchange option.

sanctions are set so that the potential criminal internalizes the costs of his actions. This is generally considered to be the role of the law of torts, and so criminal law and tort law would thus be thought of as serving the same purpose. For some crimes, such as speeding, this may be appropriate. For others, we argue, it is not.

An EUW model, by contrast, suggests a distinct role for the criminal justice system, which is not to induce efficient crimes, but rather to provide incentives for people to get what they want through voluntary transactions. This role for criminal law was first proposed by Posner (1985), but has rarely been considered in the literature since. Hylton (2005) considers a reconciliation of Posner's view of the criminal justice system with the SUW, but from a positive (rather than normative) viewpoint. Cooter and Ulen (2008) also take this view, arguing that "society is, in general, better off goods are acquired through voluntary exchange" (p. 492) and that criminal law plays a different role from that of torts, in that it is intended to deter crime and promote voluntary transactions. While this is asserted, no formal model is presented, although the authors discuss the optimum as occurring when the marginal social benefits (presumably the reduction in costs arising from crime) equal the marginal costs of deterrence. The EUW framework formalizes many of the assertions presented in Posner and Cooter and Ulen.

Furthermore, the SUW model is incompatible with the literature on private property protection (also referred to as crime avoidance). Those papers that examine avoidance, such as Shavell (1991), Hylton (1996), Hotte and van Ypersele (2008) and Mikos (2006), either use some form of cost minimization as the welfare criterion or avoid making any welfare implications altogether. The EUW framework can reconcile the two literatures, with the goal of increasing our understanding of both.

We illustrate the key features of the EUW framework by examining two models. To begin, we study a model that adheres as closely to the SUW model as possible so as to highlight the role of the voluntary option. Our simple model has many features that may be considered unattractive for some purposes, such as random matching of criminals and victims, and a fixed endowment of goods. To show that our main results can be extended past this simple setting, we also examine a search model of crime. Search models are useful for the study of crime in that they, in their essence, represent scenarios in which one person is seeking something from a non-specific person (or from a group of specific people). Crimes like assault and rape thus would seem to be represented by this type of model very well. Furthermore, search is a natural setting in which to consider issues of crime avoidance (see Curry and Doyle 2012).

The EUW approach also suggests novel explanations of some of the key features of criminal justice systems. For example, the key difference between the SUW and the EUW is the ability to negotiate. For some crimes the voluntary option does not always exist, and it is worth noting that the law reflects this as when negotiating is not possible, necessity can be allowed for as a partial defense. The EUW model can be used to explain why necessity could be a valid defense for *reducing* the sentence in a criminal case. In the SUW model, necessity could be applied to cases in which it was so obvious that the benefits to the criminal outweighed the social harm that it was unnecessary to incur the costs of punishment. Necessity could thus reduce the sentence to zero. In the EUW framework, necessity could be interpreted as the inability to negotiate. In this case, maximization of a utilitarian welfare function would entail setting the penalty to the level found in the SUW model, which (except under extreme conditions) is lower than that predicted by the extended model but still positive.

Finally, the EUW framework also offers insight as to why penalties increase in an offender's criminal history. Since the SUW model has sanctions set to make criminals internalize the externality, there is no need to increase the penalty as an individual commits more crimes. As a result, models that generate increasing penalties have to work quite hard in order to generate a result that seems fairly intuitive (see, for example Chu, Hu and Huang (2000) and Emons (2007)). In the EUW model, increasing penalties follow quite naturally from learning about the actual distribution of benefits in a setting with a finite number of agents.

For ease of exposition, the models we present will consider theft of a physical property. We believe that the results of these model generalize well to other crimes, and so a detailed discussion of the extent to which the models can be applied more generally, and the differences between the two models, will follow.

2 An Illustrative Model

The following model extends the model of Polinsky and Shavell (2000) in the simplest way possible - by adding an option of voluntary trade for potential criminals. It tries to hold as close to the SUW model as possible in order to isolate the effect that this additional aspect has.

Consider an economy with a continuum of agents who are potential criminals and another continuum of potential victims, each with mass one and all of whom are risk neutral.[3] Potential offenders differ in the benefits they receive from crime, b^o. Let $f(b)$ and $F(b)$ denote the population density function and cumulative density function of the benefits, respectively. Victims are assumed to be identical and have the property rights to something they value at b^v.

Criminals and victims are paired up at random. It is at this point that the EUW differs from the SUW. In the SUW, the potential criminal has the options of committing a crime or doing nothing. The payoff to doing nothing is normalized to zero, while the expected utility of committing a crime is $b^o - s$, where s is the expected sanction. A potential criminal will therefore commit a crime if $b^o > \bar{b} = s$. Finally, suppose that the victim suffers a harm of h over and above the loss of the good when a crime occurs and that the social cost of imposing a sanction of s on a mass M of criminals is $c(M, s)$. The welfare maximization problem is therefore given by

$$\max_s W = \int_{\bar{b}}^{\infty} b^o dF(b^o) - \left[1 - F\left(\bar{b}\right)\right][h + b^v + s] - c\left(1 - F\left(\bar{b}\right), s\right)$$

Note that if it were costless to enforce the law (i.e. if penalties were in the form of fines so that there was no social cost to punishment and if $c\left(1 - F\left(\bar{b}\right), s\right) \equiv 0$), then the optimal policy would be to set $s = h + b^v$. By doing this, crimes would be committed only if the gains to the criminal outweighed the loss to the victim, i.e. if they were efficient.

In the EUW, the criminal may either steal the property from the victim, negotiate to purchase it, or do nothing.[4] It is assumed that there are no frictions to bargaining (such as asymmetric information), so that if the criminal decides to negotiate, then

[3] Nothing in the model changes if the potential victims and criminals are the same people.

[4] For the purposes of this model, it is assumed that once the criminal makes the decision to

an agreement will be reached as long as $b^o > b^v$. It is further assumed that the victim and the criminal will agree upon a price that splits the surplus equally. If the criminal does nothing or steals the good, then the payoffs are as above. The criminal faces an expected penalty of s when stealing the good. The payoffs are as follows:

	Criminal	Victim
Negotiate	$\frac{b^o-b^v}{2}$	$\frac{b^o+b^v}{2}$
Steal	$b^o - s$	$-h$
Nothing	0	b^v

2.1 The Criminal's Decision

At this point, it shall be assumed that expected penalties, s are greater than the benefit to the victim. That is, $s \geq b^v$.[5] The following lemma establishes the (expected) utility maximizing decision for the criminal as a function of b^o.

Lemma 2.1 *A criminal will do nothing if $b^o < b^v$. If $b^o > 2s - b^v$, then the criminal will steal the good. If $b^v < b^o < 2s - b^v$, then the criminal will purchase the good.*

Letting $\tilde{b} = 2s - b^v$, the expected payoffs are therefore as follows:

$$\begin{aligned}
EU^o &= \int_{\tilde{b}}^{\infty} (b^o - s) f(b^o)\, db^o + \int_{b^v}^{\tilde{b}} \frac{b^o - b^v}{2} f(b^o)\, db^o \\
&= -s\left[1 - F\left(\tilde{b}\right)\right] - \frac{b^v}{2}\left[F\left(\tilde{b}\right) - F(b^v)\right] + \int_{\tilde{b}}^{\infty} b^o f(b^o)\, db^o + \frac{1}{2}\int_{b^v}^{\tilde{b}} b^o f(b^o)\, db^o \\
EU^v &= -\int_{\tilde{b}}^{\infty} h f(b^o)\, db^o + \int_{b^v}^{\tilde{b}} \frac{b^o + b^v}{2} f(b^o)\, db^o + \int_{-\infty}^{b^v} b^v f(b^o)\, db^o \\
&= -h\left[1 - F\left(\tilde{b}\right)\right] + \frac{b^v}{2}\left[F\left(\tilde{b}\right) - F(b^v)\right] + \frac{1}{2}\int_{b^v}^{\tilde{b}} b^o f(b^o)\, db^o + b^v F(b^v)
\end{aligned}$$

purchase, steal or do nothing, it is irrevocable. Thus the threat of crime does not factor into the bargaining process. This assumption will be relaxed in the model developed in the next section.

[5] This is tantamount to assuming that the marginal cost of punishment is not too high (at least at $s = b^v$). The case in which it would not be optimal to set the penalty this high has similar, but less clean results. The model in the following section will not entail such an assumption.

2.2 Optimality

Consider now the expected sanction that maximizes the sum of utilities less enforcement costs. It is assumed that enforcement costs depend on the mass of criminals that commit a crime, M, as well as the expected sanction so that costs are given by $c(M, s)$. From Lemma 2.1 this mass is $1 - F\left(\tilde{b}\right)$. Social welfare is therefore

$$\begin{aligned} W &= E[U^v] + E[U^o] - c(M, s) \\ &\quad - (h + s)\left[1 - F\left(\tilde{b}\right)\right] + b^v F(b^v) + \int_{b^v}^{\infty} b^o f(b^o)\, db^o - c(M, s) \end{aligned}$$

Note that the terms representing the criminals' and victims' benefits are independent of policy, s. The welfare maximization problem can therefore be written as

$$\max_s - (h + s)\left[1 - F\left(\tilde{b}\right)\right] - c(M, s)$$

which is a cost minimization problem. In particular, it is worth noting that this is equivalent to a cost minimization problem in which criminals have the binary choice of whether to steal or do nothing. That is, for every distribution $F(b^o)$ there is another distribution $G(b^o)$ such that $F\left(\bar{b}\right) = G\left(\tilde{b}\right)$ for all $\bar{b}$ and $\tilde{b}$.

3 A More General Model

In this section we extend an otherwise standard directed search model[6] to allow for the possibility of crime. In the model, potential buyers search for potential sellers in order to purchase an indivisible unit of a consumption good. In the standard model, sellers post prices below the reservation value of buyers, and any buyer who finds a seller purchases the good at the posted price. We extend the standard model to incorporate heterogeneity in buyer valuations of the consumption good and, more importantly, to allow buyers who value the good but do not wish to purchase it at the posted price the option of stealing the good instead.

[6]The directed search literature can be traced back to Peters (1984) and was developed further by Peters (1991) and Moen (1997). Our baseline model is also related to that of Burdett, Shi and Wright (2001).

We consider an economy with a large but finite number of potential sellers and an equal number of potential buyers. All potential sellers simultaneously decide whether to incur a cost, z, to create a non-divisible unit of a good which has no value to the seller but is valued by potential buyers. A seller with a unit of the good posts a price, p, in an attempt to attract potential buyers. A seller does not observe the actions of other sellers when choosing the price. Potential buyers observe the posted prices and choose which sellers to visit. Buyers choose where to shop without observing the decisions of other buyers, which creates a search friction whereby some sellers receive a queue of multiple buyers and others receive none. When multiple buyers match with the same seller we assume that sellers interact with buyers on a first come first serve basis and that the order in which buyers arrive is random.

A potential buyer who has matched with a seller may choose to i) purchase the good at the posted price, ii) steal the good, and iii) do neither. In the final case we assume that the buyer leaves without interacting with the seller and that the seller proceeds to interact with the next buyer in the queue, if one exists.

Potential buyers are heterogeneous in both the extent to which they value the good and the extent to which they suffer dis-utility from the sanctions associated with stealing. This specification allows for variation in how much offenders dislike being punished as well as differences in ability to avoid detection and differences in attitudes to risk. We assume that a buyer's valuation of the consumption good, b, is drawn from a known distribution $G(b)$. Similarly, θ is the expected disutility to an offender of committing a crime and is drawn from known distribution $F(\theta; s)$.[7] For simplicity, we assume that buyers do not realize their types until they arrive at the front of the queue, so that potential buyers are ex-ante homogenous.

In what follows, we study only symmetric subgame perfect equilibria of the game in which all sellers post the same price and all buyers use the same mixed strategy to determine where to shop. Asymmetric equilibria also exist, but will be ignored in this paper.

[7] Note that the distribution is a function of s, but for the analysis here the precise manner in which changes in s change the distribution does not matter.

3.1 A Buyer's Problem

We begin by studying the choice of a matched buyer in the final phase of the game. The buyer's decision depends on the posted price p as well as the buyer's type $\{b, \theta\}$. If $b > \theta$ and $\theta < p$ then the buyer steals the good and receives a payoff of $b - \theta$. If $b > p$ and $p < \theta$, then the buyer buys the good and receives a payoff of $b - p$. If $b < \theta$ and $b < p$ then the buyer does nothing and receives a payoff of zero.

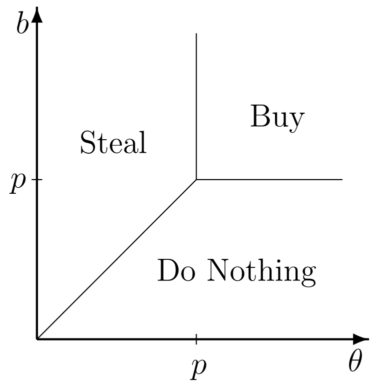

Figure 1: The Buyer's decision in (θ, b)-space.

As buyers types are realized after the match, the probability that a matched buyer buys the good given a price p is given by:

$$P_b(p) = \int_p^1 \int_p^1 dF(\theta; s) dG(b). \tag{3.1}$$

Similarly, the probability that a matched buyer chooses to steal the good given a price p is given by:

$$P_s(p) = \int_p^1 \int_0^p dF(\theta; s) dG(b) + \int_0^p \int_0^b dF(\theta; s) dG(b). \tag{3.2}$$

Given the choice of a matched buyer, we now consider the problem of a buyer choosing where to shop. Prior to matching with a seller, buyers do not know their types, the buyer must form an expectation of the value of interacting with the seller which depends on distribution of buyer valuations, $G(b)$, the distribution of criminal propensity given s, $F(\theta; s)$. The expected payoff to a matched buyer shopping from a seller advertising a price of p is given by:

$$\begin{aligned} V(p) &= \int_p^1 \int_p^1 (b-p)dF(\theta;s)dG(b) + \int_p^1 \int_0 (b-\theta)dF(\theta;s)dG(b) \\ &\quad + \int_0^p \int_0^b (b-\theta)dF(\theta;s)dG(b) \\ &= [1-F(p;s)] \int_p^1 (b-p)dG(b) + \int_p^1 \int_0^p (b-\theta)dF(\theta;s)dG(b) \\ &\quad + \int_0^p \int_0^b (b-\theta)dF(\theta;s)dG(b) \end{aligned} \tag{3.3}$$

To calculate the probability that a buyer who chooses to shop at a given seller is the first in the queue, first let $q(p)$ denote the expected number of buyers and criminals choosing to shop at a seller advertising price p. The queue length does not include potential buyers who choose not to either buy or sell in the queue length as these depart without interacting with the seller. The probability that a buyer ends up actually matching with a seller is then given by: $\frac{1-e^{-q(p)}}{q(p)}$. Therefore, the expected payoff to a potential buyer applying to a seller advertising price p is given by:

$$\left(\frac{1-e^{-q(p)}}{q(p)}\right) V(p).$$

Buyers choose which sellers to shop from based on the expected return. In a symmetric equilibrium, the probability with which any buyer chooses to shop at each seller must be the same across all buyers. This rules out pure strategies and implies that all buyers choose to shop from all sellers with some positive probability, where the precise probabilities are chose to equalize the return across sellers. Note further that since all sellers post the same price, the queue length is equal across sellers and q simply equals the ratio of buyers plus criminals in the population to sellers.

3.2 A Seller's Problem

From here we turn our attention to the decision of a seller with a unit of the good. A seller who successfully sells a unit of the good receives a payoff of p. A seller who successfully matches but is then victimized by a theft incurs a harm and receives a payoff of $-h$. The problem facing a seller is to choose a price and queue length in order to maximize expected profits:

$$\begin{aligned} \max_{p,q} \quad & (1-e^{-q})\left[\frac{P_b(p)}{X(p)} \cdot p - \frac{P_z(p)}{X(p)} \cdot h\right] \\ \text{s.t.} \quad & \left(\frac{1-e^{-q}}{q}\right) V(p) = R \end{aligned} \tag{3.4}$$

where $1 - e^{-q}$ is the probability that the seller successfully attracts at least one potential buyer, and R represents the market return that buyers receive from other sellers. That is, the constraint represents the fact that, in order to attract buyers, a seller has to choose a queue length and price combination that delivers to potential buyers the same expected utility as is being delivered by other sellers. Note that since the queue length is defined as the ratio of buyers plus criminals to sellers, the seller uses the probabilities of buying or stealing *conditional* on being a buyer or criminal. The $X(p)$ in 3.4 represents the mass of buyers plus criminals and is given by:

$$X(p) = 1 - G(p) + \int_0^p \int_0^b dF(\theta; s) dG(b). \tag{3.5}$$

The solution to the firm's problem is a pair (p^*, q^*) that generates optimal profits of $\pi(p^*, q^*; R, s)$.

3.3 Equilibrium and Welfare

There are three possible types of equilibria. First, there is an equilibrium where the costs of crime are sufficiently high that a potential seller makes negative profits even if he is the only seller in the market. In this case, all sellers decline to enter the market and no goods are exchanged. In the second type of equilibrium, the costs of crime are sufficiently low that a potential seller makes positive profits even when all other sellers enter the market. In this case, all sellers choose to enter the market. Finally, there is an interior equilibrium in which the costs of crime are sufficiently high to deter some entry, but sellers can still make profit for sufficiently high queue lengths. In this case, some but not all sellers. In an interior equilibrium, where some but not all of the potential sellers enter the market, then $\pi(p^*, q^*; R, s) = z$, as entry drives profits to zero. In this section we focus on interior equilibria, but our results can be extended to the general case.

Lemma 3.1 *In an interior equilibrium, increased crime reduces the well being of buyers.*

Proof: Start from an initial interior equilibrium with low crime, in which case $\pi(p_0^*, q_0^*; R_0, s_0) = z$. Assume sanction rise, so that $s_1 < s_0$ and crime increases. All else equal, crime reduces sellers' profits. This implies that $\pi(p_0^*, q_0^*; R_0, s_1) < z$, which implies that (p_0^*, q_0^*, R_0) is not an equilibrium when the sanction level is s_1. We now proceed to show that the equilibrium when the sanction level is s_1 requires $R_1 < R_0$.

First observe that as sellers promise more utility to buyers, i.e. as R increases, sellers' profits decrease. This is true because at an interior equilibrium the constraint on the seller's problem is binding. Therefore relaxing the constraint, by reducing R, has positive value to the seller. This implies that sellers cannot increase profits (to satisfy the entry condition that profits equal z) simply by increasing R.

What remains to be shown is that sellers cannot increase profits by changing p and q while leaving R unchanged. Suppose that the sanction level is s_1 and consider a potential interior equilibrium in which the return to buyers is R_0, but $p_1^* \neq p_0^*$ and or $q_1^* \neq q_0^*$. In order for this to be an interior equilibrium it must be that $\pi(p_1^*, q_1^*; R_0, s_1) = z$. Note that for every p and q, profits with high crime are below profits with lower crime, as at best the seller gets the same benefit of a sale, and with higher crime the probability of harm increases. Therefore $\pi(p_1^*, q_1^*; R_0, s_0) > \pi(p_1^*, q_1^*; R_0, s_1)$. Furthermore, by definition $\pi(p_0^*, q_0^*; R_0, s_0) > \pi(p_1^*, q_1^*; R_0, s_0)$, as p_0^* and q_0^* are the choices that maximize sellers' profits given R_0 and s_0.

Since $\pi(p_0^*, q_0^*; R_0, s_0) = z$, and $\pi(p_0^*, q_0^*; R_0, s_0) > \pi(p_1^*, q_1^*; R_0, s_0) > \pi(p_1^*, q_1^*; R_0, s_1)$ it must be that $\pi(p_1^*, q_1^*; R_0, s_1) < z$. Therefore it is not possible to satisfy the entry conditions without changing R. given that profits are decreasing in R, this implies that when the level of sanctions rises, along with any changes in p and q, R must fall in order to push profits up enough to generate entry. $\square$

We now turn to the main result of this section, which is to show that the welfare maximization problem can be written as a cost minimization problem. First we define social welfare in the economy where no crime occurs:

$$W_{\text{no crime}} = \left(\frac{(1-e^{-q^0})}{q^0}\right)\int_{p^0}^{1} b\, dG(b) - \left(\frac{1-G(p^0)}{q^0}\right) z, \tag{3.6}$$

where p^0 and q^0 are the equilibrium price and queue length when there is no crime. The first term is simply the aggregate benefit enjoyed by buyers of the good, which depends on the extent of the matching friction, while the second term is the total cost of entry paid by all sellers, including those who failed to match. The price paid by buyers to sellers does not enter into the welfare calculation as this is merely a transfer from buyers to sellers, which cancels out in aggregate.

In the economy where crime is possible social welfare can be written as:

$$\begin{aligned} W \;=\; & \frac{1-e^{-q^*}}{q^*}\left[\int_{p^*}^{1}\int_{p^*}^{1} b dF(\theta;s)dG(b)\right] - \frac{X(p^*)z}{q^*} \qquad (3.7)\\ & +\frac{1}{q^*}\int_{p^*}^{1}\int_{0}^{p}[(1-e^{-q^*})(b-\theta)-h]dF(\theta;s)dG(b) \\ & +\frac{1}{q^*}\int_{0}^{p^*}\int_{0}^{b}[(1-e^{-q^*})(b-\theta)-h]dF(\theta;s)dG(b) - c(s), \qquad (3.8)\end{aligned}$$

where the first term represents the gains from trades, which corresponds to the valuation of the goods received by all buyers who purchase the good. Again, the price paid to sellers does not enter as it is simply a transfer from buyers to sellers. The second term is the sum of entry costs paid by all sellers who choose to enter the market. The third and fourth terms represent the net effects of crime, including the benefits to criminals as well as the costs to sellers, on welfare. In the the third term are the effects of criminals who value the good sufficiently to be willing to purchase the good at the posted price but prefer to steal it. The net effect of this behaviour on welfare is negative, as there is no offsetting benefit to the harm created by crime to both criminal and victim. In the third term, however, are the effects of criminals who do not value the good sufficiently highly as to purchase it at the posted price, but possess sufficiently low costs of crime that they find it worthwhile to steal the good. The sign of this term is not obvious as some crimes in this category may be efficiency enhancing as they represent an allocation of the good from a seller who does not value it to someone who does and, at least for some parameter values, this benefit may outweigh the harm created by the crime. The final term, $c(s)$ represent the enforcement costs associated with a sanction level of s.

To facilitate comparison with welfare in the no-crime economy, we can re-write social welfare in the economy with crime as:

$$\begin{aligned} W &= \frac{1}{q^*}\left[\int_{p^*}^{1}[(1-e^{-q^*})b-z]dg(b)\right]-\frac{z}{q^*}\int_0^{p^*}\int_0^b dF(\theta;s)dG(b) \\ &\quad -F(p^*)\left(\frac{1-e^{-q^*}}{q^*}\right)\int_{p^*}^1 bdG(b) \\ &\quad +\frac{1}{q^*}\int_{p^*}^1\int_0^{p^*}[(1-e^{-q^*})(b-\theta)-h]dF(\theta;s)dG(b) \\ &\quad +\frac{1}{q^*}\int_0^{p^*}\int_0^{b}[(1-e^{-q^*})(b-\theta)-h]dF(\theta;s)dG(b)-c(s). \end{aligned} \tag{3.9}$$

which can in turn be written as:

$$W = W_{\text{no crime}} + \Delta T + \phi - c(s), \tag{3.10}$$

where:

$$\Delta T = \frac{1}{q^*}\left[\int_{p^*}^{1}[(1-e^{-q^*})b-z]dg(b)\right] - W_{\text{no crime}} \tag{3.11}$$

is the difference in the gains from trade in the crime and no-crime economies,

$$\begin{aligned} \phi &= -\frac{z}{q^*}\int_0^{p^*}\int_0^b dF(\theta;s)dG(b)-F(p^*)\left(\frac{1-e^{-q^*}}{q^*}\right)\int_{p^*}^1 bdG(b) \\ &\quad +\frac{1}{q^*}\int_{p^*}^1\int_0^{p^*}[(1-e^{-q^*})(b-\theta)-h]dF(\theta;s)dG(b) \\ &\quad +\frac{1}{q^*}\int_0^{p^*}\int_0^{b}[(1-e^{-q^*})(b-\theta)-h]dF(\theta;s)dG(b)-c(s). \end{aligned} \tag{3.12}$$

is the net effect of crime, including both the benefits to the criminal and the costs to the seller, and $c(s)$ is the enforcement cost associated with imposing sanction s.

Lemma 3.1 implies that $\Delta T + \phi$ is negative and decreasing in the crime rate. At an interior equilibrium, where some but not all sellers enter, the expected profits of sellers are driven to zero. As a result, social welfare is equal to the sum of the welfare of the buyers. Since all buyers are ex-ante identical, welfare is proportional to R, the market return to buyers. By Lemma 3.1, R is lower in the presence of crime than in the absence of crime. Therefore, crime reduces welfare, implying that $\Delta T + \phi$ in 3.10 must be negative. Given that the equilibrium of the standard directed search model is constrained efficient, in that a planner subject to the same matching frictions as the market would choose the same allocations as the market, the problem of maximizing W is equivalent to minimizing $\Delta T + \phi - c(s)$.

Theorem 3.2 *Maximizing a utilitarian welfare function in which offenders have the option to get what they want through voluntary trade is equivalent to minimizing costs when offenders may only commit crime or do nothing.*

4 Generalization and Comparison of the Models

As mentioned above, the assumption that criminals have an option to obtain what they want through voluntary exchange is not appropriate for all crimes. By the same token, the inclusion of criminal benefits is not controversial for many crimes. Speeding and parking tickets are examples of crimes for which the inclusion of criminal benefits does not seem controversial and for which the assumption of voluntary trade does not seem appropriate. In this section, we consider some of the crimes for which the inclusion of criminal benefits is most controversial and consider whether the assumption of voluntary exchange is appropriate. It is worth noting that, while the models above considered fairly standard market transactions, the types of voluntary exchange appropriate for these crimes may be varied. Posner (1985) argues that "it is important not to take too narrow a view of market alternatives" (p. 1199). In particular, while we have modeled voluntary exchange as occurring with the potential victim, this need not be the case. In the example of auto theft, the thief could have negotiated with the victim, or could also have gone to a car dealer. In addition, any crime committed for financial benefit has the labor market as the voluntary exchange alternative.[8]

[8]Crimes for economic benefit can easily be considered in both models we present above. In the posted price model, the sellers would be thought of as offering money and the price would be a description of what an individual had to do to earn that amount of money (e.g. hours of labor). A similar interpretation would apply to the random matching model. The results are not affected by whether the criminal steals money or an item that can be sold for an equivalent amount.

Before considering specific crimes, it is worth discussing the differences between the models considered. The first model presented was one in which agents were paired for reasons exogenous to the crime. Methodological, this is equivalent to random matching. The second model entailed price posting (sometimes called directed search). In its essence, the random matching model depicts either a scenario in which a potential criminal has stumbled across a criminal opportunity (see Curry (2012)), or a scenario in which the potential criminal can only get what they want from a specific person and this person is known to them for exogenous reasons. Directed search, on the other hand, depicts a scenario in which the potential criminal can get what they want from any one member of a particular group (in the language we use above, these are the sellers or potential victims).

How then could the theory be applied to other crimes, such as murder, assault or rape? Let us first consider murder. Buss (2005) provides perhaps the most comprehensive study of the motives of murderers. He examines FBI Homicide Databases, containing information on 429,729 murders, as well as the psychiatric files of 375 murderers from the state of Michigan.[9] People who commit murder rarely do so because they enjoy killing people; usually, murder arises as a means to stop another individual from doing something. Of the over 400,000 murders in the FBI files, less than 5% were serial killings, mass murders, gang killings or mob-ordered hits or murders of prominent people. Only 4% percent of the Michigan murderers suffered from some form of mental illness. Well over half, 56%, of the murders in the FBI files were premeditated, meaning that a conscious decision had been made to commit murder.

Furthermore, the vast majority of murder victims were killed by someone they already knew. Out of all female murder victims, 19% were killed by their current husband, 8% by their current boyfriend, 17% by an estranged husband and another 8% by a man with whom they had had a previous sexual relationship. We argue that this information implies that random matching is appropriate for modeling the crime of murder and that there was something about which negotiations could have taken place, such as ending an affair or remaining in or resuming a relationship.

[9] Murder suspects in Michigan regularly undergo psychiatric evaluation. Buss managed to get access to the files of those who were ultimately convicted and were evaluated at the Center for Forensic Psychiatry in Ann Arbor.

For assault, victims often know their assailant but less often than do murder victims. In 1999, just under half of assault victims had a prior relationship with their assailant.[10] These assaults typically stemmed from a disagreement. In other words, the assailant felt that they could get what they wanted more easily through physical violence rather than negotiation. As with murder, the random matching model would be appropriate in such a case. Another common form of assault (that is not economically driven) is one that is alcohol-fueled. The motive for such an assault is often 'respect' or 'power', or lack thereof. In these cases, respect would be the good that the victim would be 'selling' and the 'price' would be the cost of being the person who earns respect without resorting to violence. A similar story could be told about rape, independent of whether you think rape is about sex or about 'power'. With rape, the benefit to the criminal may come from either sex or a feeling of respect and power, and the 'price' is the cost of being the type of person that the victim would willingly sleep with or respect. As emphasized by Posner, one could also consider dating or marriage to be the market alternative to rape. In both cases of assault and rape, if the victim is chosen based on a prior acquaintance, or if it is based on being at the wrong place at the wrong time, then random matching would be the appropriate model. If the assailant or rapist chose their victim based on a survey of suitable people, then directed search would be the appropriate choice.

5 Extensions

At this point, it is worth asking how the predictions generated by the SUW model compare to those generated by the EUW model. Both predict that punishments should be proportional to the harm caused. One important difference, however, is that the EUW considers the harm to the victim of having suffered from a crime *but not* the foregone consumption of the good. This would help explain why rape would be penalized more than the theft of goods, no matter how valuable.

[10] Source: Criminal Victimization in the United States 1999. Washington, DC: Bureau of Justice Statistics, 2000.

5.1 Increasing Penalties

It is also worth noting that the SUW model has punishments set so that the criminal internalizes any externalities, mush as the torts system is ascribed to do. There is thus little room for penalties to reflect criminal history or whether the offender shows remorse for his actions. However, penalties that increase in one's criminal history are a pervasive phenomenon, and difficult to explain using the SUW model. The most common explanation in the literature for increasing penalties concerns mistakes, either on behalf of the criminal or the judge/jury.[11] When such errors are possible, penalties should be increasing in the certainty that the criminal meant to or actually did commit the crime, and the probability that a crime was committed (or intentional) is increasing in the number of times that the criminal is charged. This does not account for cases in which there is no uncertainty or for cases in which there is more uncertainty surrounding the second charge than the first. Other explanations, such as Polinsky and Rubinfeld (1991) and Miceli and Bucci (2005), consider the case in which the first best would entail complete deterrence (no crime), and as such are cost minimization problems.

In the EUW model, criminal history (and remorse, although we do not explicitly model it) influences the expectation of that particular agent's benefits to crime and would therefore be reflected in the sentencing. This can be seen as follows.

Consider a dynamic version of the first model described above, but with the small change that, instead of a continuum of potential criminals and victims, there is in fact one of each. The offender's benefit is private knowledge and drawn from the distribution above, now labeled $f_0(b^o)$. The cost function, $c(\cdot)$, now changes, however. When there is a single potential offender, the government hands out the first period expected punishment, s_0, with probability $1 - F\left(\tilde{b}\right)$, where $\tilde{b}$ is the threshold level for benefits above which the offender commits crime. With probability $F\left(\tilde{b}\right)$, no punishment is made. Thus the government's per period expected costs are $\left[1 - F\left(\tilde{b}\right)\right] c(s_0)$. In order to ensure an interior solution, it is assumed that expected costs get arbitrarily

[11]See, for example Stigler (1970), Rubinstein (1979), Chu, Hu and Huang (2000) and Emons (2007).

large as s_0 gets arbitrarily large. That is, $\lim_{s_0 \to \infty} \left[1 - F\left(\tilde{b}\right)\right] c(s_0) \to \infty$. Social welfare in the first period is given by

$$W(s_0) = -\left[1 - F\left(\tilde{b}\right)\right]\left[h + s_0 + c(s_0)\right]$$

In this case, the government is trading off expected harm with the expected costs of enforcement.

It is straightforward to see that the dynamic aspect to the problem does not change the criminal's behavior. The offender will commit the crime if $b^o > 2s - b^v$ as before since there is no benefit to delaying crime to the second period. In the event that no crime occurs in the first period, the government can maintain s at its current level and completely deter crime. Should a crime occur, however, the government will update its beliefs about b^o. In the second period, the government uses the distribution $f_1(b^o) = f_0(b^o | b^o > 2s - b^v)$. The government's maximization problem in the second period is therefore given by

$$\max_{s_1} -\left[1 - F_1(2s_1 - b^v)\right]\left[h + s_1 + c(s_1)\right]$$

Proposition 5.1 *Penalties are increasing in criminal history. That is, $s_1^* > s_0^*$ if the criminal commits crime in the first period.*

This proposition can easily be extended to T periods. Criminals would commit crime in a given period, t, as long as $b^o > 2s_t - b^v$. Whenever crime is committed, the government would update its beliefs over b^o and increase the penalty for the next period.

5.2 Necessity as a Defense

An interesting feature of the criminal justice system is that necessity can constitute a defense. This has not been examined much by economists.[12]

[12] To the authors' knowledge only two papers have examined necessity as a defense to criminal sanctions in the economic literature, Posner (1985) and Hylton (2005). Necessity has been examined in the context of contracts, torts and property law (see Cooter and Ulen (2008)), but rarely in the context of criminal law.

The necessity principle is nicely set out in the case *State v. Diana*[13] as follows:

> Generally, necessity is available as a defense when the physical forces of nature or the pressure of circumstances cause the accused to take unlawful action to avoid a harm which social policy deems greater than the harm resulting from a violation of the law. The defense is not applicable where the compelling circumstances have been brought about by the accused *or where a legal alternative is available to the accused.* [emphasis added]

Note that the very definition of necessity considers that offenders often have the three options specified in the EUW model, and that the cases in which they only have two (as in the SUW model) are rather special. It is also worth noting that necessity is based on the economic notion of efficiency - the defense should only be allowed when the social benefits outweigh the social costs. Recall that the SUW model uses sanctions to make offenders internalize the harm of their actions, thereby inducing efficient crimes. One possible interpretation of the necessity principle might therefore be that society could avoid unnecessary costs from punishing crimes which were *obviously* efficient. This, of course, could also apply to the EUW model, but there is another consideration.

A successful application of the necessity principle as a defense does not necessarily lead to the complete elimination of the sanction. In the textbook examples of *R. v. Dudley and Stephens*[14] and *U.S. v. Holmes*[15], necessity was found to hold, but the accused were not acquitted. In both cases, the sentences were reduced.[16] In the SUW model, there would appear to be no scope for a *reduction* in the penalty (although there would be room for elimination of the penalty in cases where the crime was obviously efficient).

In the EUW model, however, penalties would usually be set by solving the cost minimization problem. In some circumstances, bargaining is not possible, allowing

[13] State v. Diana, 24 Wn. App. 908 (1979), 604 P.2d 1312

[14] R. v. Dudley and Stephens, 14 QBD 273 DC (1884)

[15] U.S v. Holmes, Circuit Court, E. D. Pennsylvania, 26 F.Cas. 360 (1842)

[16] Both cases entailed marine accidents and the commission of murder in order to prevent further loss of life. In both cases, necessity was accepted and the sentence reduced from manslaughter to 6 months imprisonment.

for the defense of necessity. For these cases penalties would be set by solving the maximization problem without trade - the SUW model (although as mentioned above, in cases where the action was clearly efficient, penalties could be reduced to zero).

In general, one would expect the penalty to be higher in the EUW model than in the SUW model. To begin with, there are no efficient crimes (from the standpoint of the first-best) in the EUW model, while some crimes are desirable in the SUW model. Further more, penalties have a greater effect on the marginal criminal in the EUW model. Recall that in the SUW model, potential criminals commit crime if $b^o \geq s$. If the marginal criminal has $\tilde{b} = s$, then $\frac{\partial \tilde{b}}{\partial s} = 1$. In the EUW model, the marginal criminal has $\tilde{b} = 2s - b^v$, so that $\frac{\partial \tilde{b}}{\partial s} = 2$. These reasons, and the fact that $2s - b^v \geq s$ since $s \geq b^v$ by assumption, generate the result that the crime rate will be lower in the solution to the EUW maximization problem than in the solution to the SUW maximization problem.

This does not guarantee that the optimal penalty in the EUW model is higher than the optimal penalty in the SUW model. However, the conditions for this not be true are rather unusual. In particular, while an increase in the penalty has a larger effect on the marginal criminal in the EUW model, this does not necessarily translate into a greater number of criminals deterred. Suppose the penalty is set at $\bar{s}$ in both models. A marginal increase in the penalty would deter $f(s)$ additional criminals in the SUW model and $2f(2s - b^v)$ in the EUW model. If the optimal penalty occurs in a part of the distribution of benefits where $f'(\cdot) < 0$, then it is possible to have $2f(2s - b^v) < f(s)$. This is a necessary, but not sufficient condition for the counter-intuitive result that penalties are higher in the SUW model. The following proposition gives the exact condition for penalties to be lower in the SUW model than those in the EUW model.

Proposition 5.2 *A necessary and sufficient condition for penalties to be higher in the EUW model is*

$$F\left(\tilde{b}\right) - F(s^*) + 2(h + s^*) f\left(\tilde{b}\right) - (h + b^v) f(s^*) + 2c_M f\left(\tilde{b}\right) - c_M f(s^*) > 0 \quad (5.1)$$

The proof is in the Appendix.

In general, as long as the probability distribution for benefits to criminals does not slope downward too steeply, penalties will be higher in the EUW model. Figure 2 depicts a scenario in which penalties are higher in the SUW model.

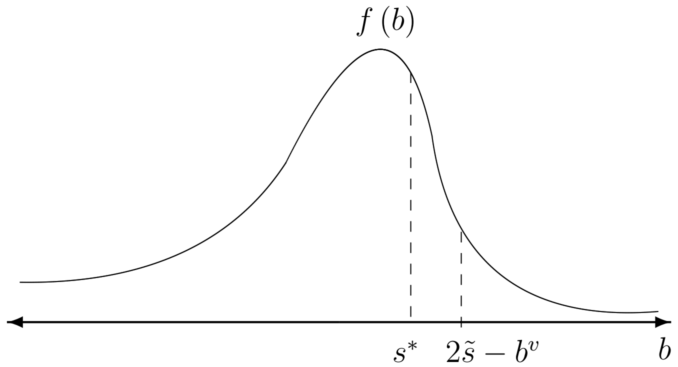

Figure 2: For this pdf, the optimal penalty for the SUW model is s^* and the optimal penalty for the EUW model is $\tilde{s}$. Note that $2\tilde{s} - b^v > s^*$ and $f\left(s^*\right) > 2f\left(2\tilde{s} - b^v\right)$.

6 Conclusion

This paper explicitly considers the normative aspect of the economics of crime. It proposes that the current model typically used is misspecified and that this misspecification has been the source of considerable controversy in the literature. This paper presents a model that maintains the central insights of the current literature while reconciling the Pareto principle with the objections that people have with the inclusion of the benefits of crime in a social welfare function.

This paper is not the first to introduce search theory into the modeling of crime, however it may be the first to carefully consider the relative benefits to using either random matching or directed search. Certainly a more focussed examination would seem warranted. Finally, this paper also provides a foundation for determining what the true costs of crime are. A proper analysis, however, would entail a model in which agents could invest in protection from crime. This analysis is done in Curry and Doyle (2012).

7 Appendix

Proof to Proposition 3.4 The optimal penalty for the SUW model solves

$$\max_s W = \int_{\bar{b}}^{\infty} b^o dF\left(b^o\right) - \left[1 - F\left(\bar{b}\right)\right]\left[h + b^v + s\right] - c\left(1 - F\left(\bar{b}\right), s\right)$$

and the FOC is

$$-sf\left(s\right) - 1 + F\left(s\right) + \left[h + b^v + s\right] f\left(s\right) - c_s + c_M f\left(s\right) = 0 \tag{7.1}$$

The optimal penalty for the EUW model solves

$$\max_s W = -\left(h + s\right)\left[1 - F\left(\tilde{b}\right)\right] - c\left(1 - F\left(\tilde{b}\right), s\right)$$

and the FOC is

$$-1 + F\left(2s - b^v\right) + 2\left(h + s\right) f\left(2s - b^v\right) - c_s + 2c_M f\left(2s - b^v\right) = 0 \tag{7.2}$$

Let s^* denote the optimal sanction in the SUW model (i.e. the level of s that solves 7.1). Evaluating 7.2 at s^* yields

$$\left[F\left(2s^* - b^v\right) - F\left(s^*\right)\right] + \left[2\left(h + s^*\right) - \left(h + b^v + s^*\right) f\left(s^*\right)\right] + \left[2c_M f\left(2s^* - b^v\right) - c_M f\left(s^*\right)\right] \tag{7.3}$$

If this expression is positive, then it must be that the EUW model has a solution $\tilde{s} > s^*$.

Further note that it must be that $F\left(2s^* - b^v\right) - F\left(s^*\right) \geq 0$ since the EUW model assumes that $s \geq b^v$. If $c_M = \alpha$, then the last term in 7.3 is positive. Thus a sufficient condition for 7.3 to be positive is that the middle term is non-negative, or $2\left(h + s^*\right) \geq \left(h + b^v + s^*\right) f\left(s^*\right)$. ■

References

[1] Becker, Gary S. (1968), "Crime and Punishment: An Economic Approach," *Journal of Political Economy* **76**, pp. 169–217.

[2] Burdett, Kenneth, Shouyong Shi and Randall Wright (2001) "Pricing and Matching with Frictions," *Journal of Political Economy*, **109**, pp. 1060-1085.

[3] Buss, David M. (2005) *The Murderer Next Door: Why the Mind is Designed to Kill*, Penguin Books: Toronto.

[4] Chu, C.Y. Cyrus, Sheng-cheng Hu, Ting-yuan Huang (2000) "Punishing repeat offenders more severely," *International Review of Law and Economics*, **20**, pp. 127-140.

[5] Cooter, Robert and Thomas Ulen (2008) *Law & Economics*, 5$^{\text{th}}$ edition, Pearson Addison Wesley: Boston.

[6] Curry, Philip A. (2012) "Malice Aforethought," working paper.

[7] Curry, Philip A. and Matthew Doyle (2012) "On the Co-Existence of Criminal Sanctions," working paper.

[8] Dharmalapala, Dhammika and Nuno Garoupa (2004) "Penalty Enhancement for Hate Crimes: An Economic Analysis," *American Law and Economics Review*, **6**, pp. 185–207.

[9] Emons, Winand (2007) "Escalating penalties for repeat offenders," *International Review of Law and Economics*, **27**, pp. 170–178.

[10] Hotte, Louis and Tanguay van Ypersele (2008) "Individual Protection Against Property Crime: Decomposing the Effects of Protection Observability", *Canadian Journal of Economics*, **41**, pp. 537–563.

[11] Hylton, Keith N. (1996) "Optimal Law Enforcement and Victim Precaution," *Rand Journal of Economics* **27**, pp. 197–206.

[12] ———— (2005) "The Theory of Penalties and the Economics of Criminal Law," *Review of Law and Economics*, **1**, pp. 1–27.

[13] Kaplow, Louis (1992) "The Optimal Probability and Magnitude of Fines for Acts that Defintely Are Undesirable," *International Review of Law and Economics*, **12**, pp. 3–11.

[14] Miceli, Thomas J. and Catherine Bucci (2005) "A Simple Theory of Increasing Penalties for Repeat Offenders," *Review of Law and Economics*, **1**, pp. 70–79.

[15] Mikos, Robert A. (2006) "'Eggshell' Victims, Private Precautions, and the Societal Benefits of Shifting Crime," *Michigan Law Review*, **105**, pp. 307–351.

[16] Moen, Espen (1997) "Competitive Search Equilibrium," *Journal of Political Economy* **105**, pp. 385–411.

[17] Peters, Michael (1984) "Bertrand Equilibrium with Capacity Constraints and Restricted Mobility," *Econometrica*, **52**, pp. 1117-1128.

[18] ———— (1991) "Ex Ante Price Offers in Matching Games: Non-Steady States." *Econometrica*, **59**, pp. 1425-1454.

[19] Polinsky, A. Mitchell and Steven Shavell (2000) "The Economic Theory of Public Enforcement of Law," *Journal of Economic Literature*, **38**, pp. 45–76.

[20] Posner, Richard A. (1985) "An Economic Theory of the Criminal Law," *Columbia Law Review*, **85**, pp. 1193–1231.

[21] Rubinstein, Ariel (1979) "An Optimal Policy for Offenses that May Have Been Committed By Accident," in *Applied Game Theory*, ed. by S. Brams, A. Schotter and G. Schwodiauer, Wurzberg: Physica-Verlag, pp. 406–413.

[22] Shavell, Steven M. (1991) "Individual Precautions to Prevent Theft: Private versus Socially Optimal Behavior," *International Review of Law and Economics*, **11**, pp. 123–132.

[23] Stigler, George J. (1970) "The Optimum Enforcement of Laws," *Journal of Political Economy*, **78**, pp. 526–536.