Punishment, Deterrence, and Avoidance

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Abstract

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DETERRENCE AND AVOIDANCE

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ABSTRACT

This paper explores the effects of public enforcement, in general, and punishment, in particular, on crime levels if offenders can engage in avoidance activities. Avoidance reduces the probability or magnitude of punishment. In general, offenders can reduce their expected punishment either by substituting legal for criminal activities (the deterrent effect) or by increasing avoidance activities. This paper shows that increasing the direct costs of crime – by either increasing punishment or enforcement efforts – does not necessarily deter criminal activity and may actually trigger increased crime, if avoidance is possible. Furthermore, this paper shows that increasing the opportunity costs of crime (e.g., by subsidizing legal alternatives or through education or vocational programs) reduces both crime and avoidance and in this respect is advantageous. The conditions for such outcomes are identified, the economic mechanisms explained, and an underlying intuitive approach for these results proposed.

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1. INTRODUCTION

The economic model of criminal behavior and law enforcement explains how the incentives to engage in crime are affected by the relative prices of legal and illegal activities, and describes the effect of various policy tools – punishment, enforcement effort, and opportunity costs of crime – on these parameters. For example, increasing the expected punishment should reduce criminal activities, which would seem to be common sense. Higher probability or severity of punishment increases the expected costs or the price of criminal activities, thereby reducing crime levels.

This paper explores a phenomenon that casts doubt on the commonly expected result of criminal behavior and law enforcement: namely, the observation that offenders can, and usually do, engage in various avoidance activities.

Avoidance generally involves costly activities aimed at decreasing the expected punishment either by reducing the probability of punishment (apprehension or conviction) or its magnitude. This is undoubtedly a widespread phenomenon, e.g., offenders may cover up incriminating evidence, cook their books, flee from the scene of the crime, invest in litigation, abuse evidentiary rules and procedures, and so on and so forth.

Interestingly, though ubiquitous, criminal avoidance has been given very little attention in the economic literature of crime.1 Actually, Ehrlich (1972, 1973) pointed out that increasing the punishment level for offenders engaging in what he termed self-protection does not necessarily reduce their crime level. As he put it, "an increase in [punishment]...will generally increase an offender's incentive to spend resources on self-protection.... This may decrease the probability of his being apprehended and punished
which in turn may at least partly offset the deterrent effect of [punishment]" (Ehrlich, 1972, p. 266).² However, this short note in Ehrlich's work has gone largely unnoticed.³

This paper expands on Ehrlich's note and takes it further in several respects. Three contributing factors to the final outcome of various policy tools on crime are described: (1) Direct effects on crime; (2) Direct effects on avoidance and; (3) The cross-effect between crime and avoidance, which has been largely neglected to date. The key insight is that crime and avoidance are generally complements, in the sense that more crime induces more avoidance, and vice versa. This is because more crime increases the (marginal) benefits of investing in avoidance, and investing more in avoidance reduces the (marginal) costs of engaging in crime. This complementarity, combined with the direct effects on crime and avoidance, leads to several interesting and counter-intuitive results. For example, in contrast to common intuition, increased punishment neither decreases crime nor increases avoidance necessarily. In fact, more punishment may, and under certain conditions will, result in more crime. To illustrate the latter point and provide a taste of the analysis, consider how a small additive, constant increase in punishment across all levels of criminal activities would affect the behavior of offender who partly engage in criminal activities and invest in avoiding punishment. Such an increase would have no direct effect on the choice of crime since it does not alter marginal expected sanctions. Yet, since total punishment is now higher, the marginal benefit from avoidance is greater, inducing offenders to invest more in avoidance. But

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¹ Exceptions include Malik (1990), Stanley (1995a, 1995b), Innes (2001), and recently Sanchirico (2006).
² Ehrlich noted that an increase in the probability of punishment is not expected to generate a similar effect unless the offender is risk preferrer. This paper reaches different results, see Section 5A. Stanley (1995) in an unpublished paper offers a case in which these counter-effects may take place. Yet, he neither proves its existence in general nor provides general conditions for it. Furthermore, the intuition offered by Stanley is rather specific to the case presented. As will become apparent, this paper offers a more precise and refined intuition, and a much extended analysis.
once offenders invest more in avoidance, the probability of punishment falls, and marginal expected sanctions fall as well. This complementary effect increases crime levels.\(^4\)

As the flip-side of this analysis, increasing the cost of crime (i.e., expected punishment) might lead to decreased avoidance activities. Thus while increased punishment directly reinforces incentives to engage in avoidance, owing to the complementarity effect, reduced crime (because of deterrence) works in the opposite direction.\(^5\)

This paper compares the effects of avoidance on various enforcement tools with respect to crime and avoidance. Accordingly, the effects of tightening enforcement measures crucially depend on the available technologies of enforcement and avoidance: while some enforcement technologies trigger further avoidance, others may hamper the effectiveness of avoidance. For example, random inspection (e.g., higher auditing rates for taxpayers) may trigger increased avoidance aimed at concealment during inspection (e.g., more sophisticated tax planning and better legal tax advice ex ante) that might indirectly induce more crime. By contrast, more thorough inspection may hamper the effectiveness of avoidance efforts, thereby directly reducing avoidance and crime.

Furthermore, programs aimed at increasing the opportunity costs of crime, such as work subsidies, decrease crime without directly inducing investment in avoidance. The

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\(^4\) It should be stressed at the outset that increasing punishment makes offenders unambiguously worse off. The point is, however, that it does not necessarily follow that offenders' best reaction would be to decrease their criminal activity; they might choose the opposite.

\(^5\) This result conflicts with Malik (1990) ("However, an increase in the magnitude of the fine unambiguously raises the individual's avoidance outlays, which is consistent with intuition") and Innes (2001)("However, with the prospect of a higher sanction, violators have a greater incentive to avoid apprehension"). The differences between the present paper and Malik's and the reasons for the different results are explained later. See infra note 58.
use of such programs would indirectly reduce investment in wasteful avoidance (complementarity). Thus, this paper reveals a neglected advantage that these programs enjoy. Lastly, the paper provides throughout intuitions for translating the economic results into policy measures.

This paper is naturally related to the economic literature explaining the limits of the deterrent effect of punishment. From early on, the negative correlation between punishment and deterrence was not theoretically robust. Ehrlich (1973), for example, showed that, for offenders preferring risk, an increased level of punishment (at least a small one) would have an ambiguous effect on their level of criminal activity. In addition, if the problem is not simply a choice between legal and criminal income-producing activities, but also involves leisure time, then an increased punishment would not necessarily reduce the crime level. Further, Block and Heineke (1975) demonstrated that the deterrent effect of expected punishment (and other variables) follows from the common assumption of independence of "psychic costs" and wealth. Similarly, the marginal deterrence literature, initiated by Stigler (1970), offers another explanation for a possible positive relationship between punishment and crime levels. This paper adds another explanation for the limited deterrent effect of punishment.

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6 This is because an increased punishment creates two effects: on the one hand, it reduces the expected returns from crime, generating a substitution effect in favor of alternative legal activities. But, on the other hand, it increases the risk associated with crime. For risk seeking offenders the latter effect may partly, fully, or more than offset the substitution effect (at least for a small increase in punishment). An increase in the probability of punishment, on the other hand, will unambiguously reduce criminal activities by risk seeking offenders.

7 See, for example, Schmidt and Witte (1984). This is because, with variable leisure time, changes in punishment not only lead to a substitution effect, but also an income effect. As long as leisure time is a normal good, this income effect induces offenders to increase income-producing activities, including crime.

8 By "psychic costs", Block and Heineke refer to preferences potential offenders have for time spent in legal or criminal activity, which are equivalent to preferences they have to income derived from legal or criminal activity.
This paper is also related to the recent literature on avoidance such as Malik (1990). However, it differs from this literature in several important respects. First, Malik's work is normative in nature while the present analysis is mainly positive. Second, Malik's model assumes that offenders' choice of crime is a binary choice – whether to commit a certain crime or not – while the present analysis allows for different levels (or degrees) of crime. This difference is crucial. A binary model such as Malik's implicitly discards the possibility of cross-effects between avoidance and crime, which are central to the present paper. Indeed, although Malik does not examine explicitly the effects of increased punishment on crime, crime cannot increase with higher punishment under his model. This obviously stands in sharp contrast to one of the main results in this paper.

This paper proceeds as follows. Section 2 develops a model of criminal behavior, taking avoidance efforts into account. Section 3 develops the main results and intuitions, focusing on the policy tool of punishment. Accordingly, this section analyzes the possible effects of increased punishment on crime and avoidance and identifies the conditions under which crime may rise. Section 4 shows the generality of these results by relaxing various assumptions. Section 5 considers the other main policy tools, such as enforcement efforts and subsidizing legitimate alternatives. It shows how and why various policy tools affect crime differently, if there is avoidance. Section 6 summarizes several policy implications and concludes.
2. THE MODEL

To analyze the effects of punishment on criminal activities and avoidance expenditures, this paper employs a simple version of Ehrlich’s (1973) model of crime. Like other models for property crimes, the criminal choice problem is formulated as a portfolio model of labor supply in which time is allocated between legal and criminal activities, and the returns to the latter are uncertain. The model, however, can easily be interpreted as a model of wealth or other allocations between legal and criminal endeavors. Indeed, this model easily applies to property crimes, such as tax evasion, embezzlement, fraud, insider trading, corruption, and so on and so forth, and regulatory offences, such as road safety rules, pollution-control regulation, minimum wage statutes, health guidelines, work-safety laws, bank-reserve ratios, nuclear safety, and so on and so forth. For example, the model is applicable to a firm choosing activities or inputs, some of which are illegal, or to taxpayers deciding how much to underreport. The model is extended to include, as well as choice of crime level, the decision of how much to invest in avoiding punishment.

Assume then that potential offenders can participate in only two market activities, denoted generally as work and crime, and that they can choose their optimal allocation of time or other resource between these two activities at the beginning of a given period. There are no training or other entry costs with either of the activities, and movement between them is costless. A total amount of time, $T$, normalized to one, can be allocated

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9 Ehrlich's model of criminal behavior, which belongs to an important family of models in this field, is considered to be standard in the literature. See, e.g., Heineke (1978), Schmidt and Witte (1984), Eide (1999).
between these two activities, a fraction \( a \) to crime and a fraction \( 1 - a \) to work, where \( 0 \leq a \leq 1 \). Time allocated to all non-market activities (leisure activities) is fixed.\(^{10}\)

Assume that the returns on both legal and criminal activities are monotonically increasing functions of time. Work, on the one hand, is safe in the sense that the net returns are given with certainty by the function \( w(a) \) exhibiting decreasing marginal returns, so that \( w'(a) < 0 \) and \( w''(a) < 0 \).\(^{11}\) Crime, on the other hand, is risky in the sense that the net returns are conditional on at least two states of the world: punishment or non-punishment at the end of the period. In contrast to most previous models, in which the subjective probability of punishment, \( p \), is constant and exogenously determined,\(^{12}\) in our model, the probability of apprehension, conviction and punishment is assumed to depends on offenders' investment in avoidance, i.e., on measures to conceal their identity or crime, \( e \).\(^{13}\) Consequently, offenders are apprehended, convicted and punished with probability \( p(e) \).\(^{14}\) Assume investing in avoidance reduces the probability of punishment but with decreasing rates, so \( p'(e) < 0 \) and \( p''(e) > 0 \). If successful,

\(^{10}\) While this assumption is to some extent unrealistic it allows us to concentrate on the diluting effects of avoidance activities on the deterrent effect of increased punishment. As noted in the Introduction, the deterrent effects of increasing punishment in a time-allocation model with variable leisure time are ambiguous even without avoidance activities. See, for example, Schmidt and Witte (1984).

\(^{11}\) For ease of notation, the returns from legal activities are defined as a function of time allocated to crime rather than work. Since the returns from legal activities, as a function of time allocated to work, \( (1 - a) \), exhibit decreasing marginal returns, then \( w'(1 - a) > 0 \) and \( w''(1 - a) < 0 \), and, consequently, the returns from legal activities, as a function of time allocated to crime, also exhibit decreasing marginal returns, then \( w'(a) < 0 \) and \( w''(a) < 0 \). Certainty with respect to the returns from legal activities is not crucial to our results.


\(^{13}\) For simplicity, avoidance activities are assumed not to be constrained by budget (i.e., do not require time and effort), and avoidance is fixed, i.e., affects all levels of criminal activities. Both assumptions do not affect the main results of this paper qualitatively, and are relaxed in Section 4.

\(^{14}\) It is assumed that the probability of apprehension, conviction and punishment is a function of avoidance expenditures only. In Section 4, the analysis is extended to examine the consequences of making the more realistic assumption that the probability of punishment is a function of avoidance expenditures and criminal activity, i.e., \( p(e, a) \). In addition, Section 4 examines the effects of changes in the enforcement effort by
offenders receive the net returns from their crime in monetary or their equivalent, which are given by the function \( c(a) \), which is also assumed to be concave, so that \( c'(a) > 0 \) and \( c''(a) < 0 \). If offenders are unsuccessful, the returns from crime are reduced by sanctions, given by the function \( f(a) \), exhibiting increasing marginal severity, so that \( f'(a) > 0 \) and \( f''(a) > 0 \). The function \( f(a) \) includes monetary and monetary-equivalent sanctions, such as imprisonment or stigma. Assume further that imposing punishment is costly.

Under the above assumptions, the problem becomes choosing \( a \) and \( e \), subject to \( 0 \leq a \leq 1 \), which maximizes:

\[
E[U(\cdot)] = p(e)U(Y) + (1 - p(e))U(X).
\]

Where:

\[
X = w(a) + c(a) - e
\]
\[
Y = w(a) + c(a) - f(a, \beta) - e
\]

are terminal wealth at the end of the period, with non-punishment and punishment, respectively. \( U(\cdot) \) is the individual's von Neumann-Morgenstern utility function defined over terminal wealth, and \( \beta \) is a "shift parameter," which is used below to examine the effects of changes in punishment. Assuming that the individuals are risk-neutral, the maximization problem (1) reduces to:

\[
EW = w(a) + c(a) - e - p(e)f(a, \beta).
\]

16 The reasons for costly punishment include: offenders' judgment-proofness and the costs of imposing imprisonment.
17 Other risk preferences are examined below in Section 4.
The first-order conditions of an interior maximum of (3) are:

\[ H_a = w'(a) + c'(a) - p(e) f_a(a, \beta) = 0 \]  
\[ H_e = -p'(e) f(a, \beta) - 1 = 0 \]

Re-arranging, gives the following optimum conditions:

\[ -w'(a) = c'(a) - p(e) f_a(a, \beta) \]  
\[ -p'(e) f(a, \beta) = 1 \]

These first-order conditions have a simple interpretation. Condition (4') implies that in equilibrium, offenders choose their optimal level of crime, denoted \( a^* \), where the marginal returns from legal activities equal the marginal expected returns from criminal activities (taking into account the effects of avoidance expenditures on the probability of punishment and, therefore, on the marginal expected punishment); Condition (5') implies that offenders choose the optimal investment in avoidance, denoted \( e^* \), where the last dollar spent on avoidance equals its marginal “benefit” in terms of the marginal reduction in expected punishment (taking into account the level of punishment as a result of time allocated to crime).

Risk-neutral offenders do not necessarily maximize expected wealth by combining legal and criminal activities, but might specialize in either work or crime.\(^{18}\) This paper, however, focuses on the case in which offenders combine work and crime, i.e., assumes an interior solution to the optimization problem.\(^ {19}\)

\(^{18}\) The conditions for specialization in either legal or illegal activity are developed below. See footnotes 33 and 34.
\(^{19}\) The second-order conditions are satisfied by the above assumptions and the following sufficient condition:

\[ \frac{f'(a, \beta) f_{aa}(a, \beta)}{f_a(a, \beta)^2} \geq \frac{p'(e)^2}{p(e) p''(e)}. \]
3. THE EFFECTS OF PUNISHMENT ON CRIME AND AVOIDANCE

Consider now the effects of changes in punishment level on incentives to engage in criminal and avoidance activity. Assume, without loss of generality, that \( f_{\beta}(a, \beta) > 0 \).

Implicit differentiation of the first-order conditions at equilibrium levels of crime and avoidance, \( a^* \) and \( e^* \), with respect to \( \beta \), gives:

\[
\frac{da^*}{d\beta} = \frac{1}{|H|} \left[ H_{ea} \frac{\partial H_e}{\partial \beta} - H_{ee} \frac{\partial H_a}{\partial \beta} \right]
\]

\[
\frac{de^*}{d\beta} = \frac{1}{|H|} \left[ H_{ea} \frac{\partial H_a}{\partial \beta} - H_{aa} \frac{\partial H_e}{\partial \beta} \right]
\]

where \( |H| = \begin{vmatrix} H_{aa} & H_{ea} \\ H_{ae} & H_{ee} \end{vmatrix} \) and \( H_y = \frac{\partial EW}{\partial \hat{\beta}} \).

Solving equation (6) yields:

\[
\frac{da^*}{d\beta} = \frac{1}{|H|} \left[ p'(e)^2 f_a(a, \beta) f_{\beta}(a, \beta) - p(e) p''(e) f(a, \beta) f_{\beta}(a, \beta) \right]
\]

The sign of \( \frac{da^*}{d\beta} \) follows the sign of the terms in the brackets, i.e., \( \frac{\partial a^*}{\partial \beta} \leq 0 \) as

\[
\frac{p'(e)^2}{p(e) p''(e)} \leq \frac{f(a, \beta) f_{\beta}(a, \beta)}{f_a(a, \beta) f_{\beta}(a, \beta)}
\]

It is interesting to examine whether the LHS can be greater than or equal to the RHS in (8), i.e., whether the possibility of avoidance may induce offenders to increase, or at least
not decrease, their criminal activity in response to greater punishment. As it turns out, this indeed occurs in various situations; for certain changes in the punishment structure.\textsuperscript{20} Note that the LHS of (8) is strictly positive if there is avoidance (i.e., $e > 0$). So, e.g., if $f_{a\beta}(a, \beta) = 0$, the RHS is zero, and crime necessarily increases with punishment.\textsuperscript{21} Such modification of punishment structure is not unreasonable. It means that punishment increases independently of the level of criminal activity, as in the punishment structure $f(a, \beta) = f(a) + \beta$, implying an additive, constant punishment increase across all levels of crime. The intuition of this unexpected result is straightforward: constant additive changes in punishment do not affect the marginal costs of crime and thus have no (direct) effect on crime ($\frac{\partial H_e}{\partial \beta} = -p(e)f_{a\beta}(a^*, \beta) = 0$). Yet, higher punishment increases the marginal benefit of avoidance, thereby inducing investment in avoidance ($\frac{\partial H_e}{\partial \beta} = -p'(e)f_{b\beta}(a^*, \beta) > 0$). Higher avoidance, in turn, reduces the marginal expected costs of crime, thereby increasing it.

Although the possibility of such constant additive changes in punishment being intentionally adopted is unlikely, it may exist in reality. Think, for example, on the penalizing effect of pretrial detention. Typically, criminal law allows for a certain period of arrest before trial, which is limited, but from certain point largely independent of the severity of criminal activity. In fact, this is how pre-trial detention works in Israel. Reforming these time periods could be considered as an additive constant change in

\textsuperscript{20} Note that condition (8) does not violate the second-order sufficient condition in Footnote 17.
\textsuperscript{21} Although the same results can be shown more easily with a fine structure giving $f_{a\beta}(a, \beta) < 0$, this option is ignored for two main reasons: (1) It is unlikely that such a structure would be intentionally
punishment.\footnote{22} Another example is detention following an extradition request, which usually allow for an unlimited period, i.e., until extradition, for alleged crimes above a certain threshold. Alternatively, consider the psychic effects associated with criminal activity, such as stigma. Such costs may be independent of crime level to some extent.\footnote{23} Thus, variations in stigma costs may also represent constant additive changes in punishment. Similarly, revocation, rather than suspension of professional licenses, is also a constant punishment. Fluctuations in market prices for professional services imply changes in professional license values, and hence constant punishment by revocation. The above examples are admittedly unusual, and in view of our finding of a constant additive increase in punishment leading to more crime, such punishment modifications are extremely rare, as would be expected. However, the possibility of constant additive changes in punishment is not the main point. If such punishment modifications strictly increase crime, non-constant additions \textit{may} clearly increase it. Consider a penalty structure of the form $f(a, \beta) = f(a) + \beta a^\epsilon$, whereby $f_{\beta \beta}(a, \beta) > 0$ for all $c > 1$, which corresponds to the notion of increased punishment leading to rises in both absolute and marginal punishment levels. In this case, the RHS of (8) is positive but less than 1, if $c/a < f_a(a, \beta)/f(a, \beta)$. To complete this example, a certain probability of detection structure yielding a LHS of (8) more than or equal to 1 is required. This occurs, for example, with the set of probability functions, $p(e) = \frac{\delta}{\alpha^e}$, where $\alpha > 1$ is any real numbers. However, the possibility of constant additive changes in punishment is not the main point. If such punishment modifications strictly increase crime, non-constant additions \textit{may} clearly increase it. Consider a penalty structure of the form $f(a, \beta) = f(a) + \beta a^\epsilon$, whereby $f_{\beta \beta}(a, \beta) > 0$ for all $c > 1$, which corresponds to the notion of increased punishment leading to rises in both absolute and marginal punishment levels. In this case, the RHS of (8) is positive but less than 1, if $c/a < f_a(a, \beta)/f(a, \beta)$. To complete this example, a certain probability of detection structure yielding a LHS of (8) more than or equal to 1 is required. This occurs, for example, with the set of probability functions, $p(e) = \frac{\delta}{\alpha^e}$, where $\alpha > 1$ is any real numbers. However, the possibility of constant additive changes in punishment is not the main point. If such punishment modifications strictly increase crime, non-constant additions \textit{may} clearly increase it. Consider a penalty structure of the form $f(a, \beta) = f(a) + \beta a^\epsilon$, whereby $f_{\beta \beta}(a, \beta) > 0$ for all $c > 1$, which corresponds to the notion of increased punishment leading to rises in both absolute and marginal punishment levels. In this case, the RHS of (8) is positive but less than 1, if $c/a < f_a(a, \beta)/f(a, \beta)$.

\footnotetext{22} Indeed, the rules governing the duration of pre-trial detention in Israel were changed in 1996.

\footnotetext{23} See, for example, Kahan and Posner (1999, p. 373); Viscusi and Zeckhauser (1979, p. 440).
number, and $0 < \delta \leq 1$, which retains the properties of $p(e)$, and with the LHS equal to 1. Thus, under these conditions, crime increases with punishment.\(^{24}\)

Next, solving equation (7) yields:

$$\frac{de^*}{d\beta} = \frac{1}{H} \left[ p'(e)[p(e)[f_a(a, \beta)f_{\alpha\beta}(a, \beta) - f_{\beta}(a, \beta)f_{\alpha\alpha}(a, \beta)] + f_{\beta}(a, \beta)[w''(a) + c''(a)]\right]$$

The sign of $\frac{de^*}{d\beta}$ follows the sign of the terms in the brackets, and can be negative, i.e., avoidance activity counter-intuitively decreases with higher punishment only if:

$$\frac{p'(e)^2}{p(e)p''(e)} < \frac{f(a, \beta)f_{\alpha\beta}(a, \beta)}{f_a(a, \beta)f_{\beta}(a, \beta)}.$$  

For example, the functions $f(a, \beta) = \beta f(a) + \beta^c$ (for $\beta \geq 1$ and $c > 1$) and $p(e) = \frac{\delta}{\alpha^c}$ fulfill this necessary condition. Note that while the LHS of (9) is always strictly positive, the RHS approaches zero as $c$ approaches infinity and $\beta$ approaches 1. Therefore, it is also possible that stricter punishment would lead to less, rather than more, investment in avoidance. The explanation for this counter-intuitive result is similar to that given above for the sign of Equation (6). Higher punishment levels increase the marginal benefit of avoidance, thereby directly increasing incentives to avoid punishment. However, if this higher level of punishment is fulfilled via a sharp rise in marginal punishment of criminal activity, the latter decreases sharply, and accordingly sufficiently reduces the marginal

\(^{24}\) Alternatively, assume the following punishment structure $f(a, \beta) = \beta f(a)$, where $\beta > 1$. In this case, the RHS of equation (8) equals 1, and, with the above structure of probability of detection, crime is unaffected by the level of punishment, i.e., $\frac{da^*}{d\beta} = 0$. 

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benefit of avoidance; thus, investment in avoidance indirectly falls. The latter indirect
effect on avoidance may outweigh the former direct effect.

Further, comparing (8) and (9), although greater punishment may generate higher
crime level or lower investment in avoidance, clearly these effects cannot occur
simultaneously. Indeed, in view of the complementarity between crime and avoidance, if
criminal activity increases, avoidance must also increase, and if avoidance falls, so does
the crime level.

Accordingly, in general, changes in punishment affect directly both criminal
activity and investment in avoidance. These direct effects are quite intuitive: the
deterrence effect (i.e., higher marginal cost of crime) reduces crime, and the avoidance
effect (i.e., higher benefit of avoidance) increases investment in avoidance. Yet, the
cross-effect between crime and avoidance has typically been ignored. Greater investment
in avoidance reduces marginal expected punishment, thereby inducing more crime.
Similarly, a lower level of crime reduces the expected punishment, thereby decreasing the
marginal benefit of avoidance. Therefore, the complementarity of crime and avoidance
may induce counter-intuitive effects due to changes in punishment.

The examples presented above not only prove that contra-intuitive effects on
crime and avoidance are possible, but provide insights into how punishment
modifications should be structured. In particular, the smaller the effect of an increase in
punishment – $\beta$ – on marginal punishment, and the larger its effect on total punishment,
the higher the chances that crime will increase. Similarly, investment in avoidance may
decrease in reaction to opposite effects. Thus, the ratio of the change in marginal
expected punishment to that in total expected punishment is of great importance in the
design of punishment structure and sentencing guidelines.25

4. EXTENSIONS

This section relaxes a few assumptions and extends the analysis in various
directions. The insights and possible results in this paper with respect to the structure of the offender's problem are shown to be robust. The effects of changes in punishment on crime and avoidance can be analytically separated into three components: the direct effects on crime and avoidance, and the cross-effects between avoidance and crime. Generally, as long as avoidance and crime remain complements and the direct effects operate 'regularly,' the qualitative results of this paper follow through. The main results are summarized in Table 1.26

Crime Affects Detection: Consider first the possibility that the probability of detection is a function of both crime and avoidance levels. This might be reasonable since greater involvement in crime may increase the likelihood of detection.27 Formally, the model in (3) can be restructured by assuming \( p(a,e) \), \( p_a(e,a) > 0 \) and \( p_{ea}(a,e) > 0 \).28 Accordingly, offenders would now also consider the effect of their criminal activity on the probability of detection. With this model, it can be easily verified that the direct

25 Note that the rationale and policy recommendations (and policy measure) differ from those in the marginal deterrence literature.
26 Formal proofs of the results are on file with the authors.
27 Indeed, the opposite conjecture may also be valid, i.e., the greater the engagement in criminal activity, the lower the probability of detection, conviction and punishment, because offenders would become "specialized." Note also that both these effects may be included in the model by specifying that a greater degree of specialization in crime would increase efficacy of investment in avoidance; formally, \( p_{ea}(a,e) < 0 \).
28 An interior solution entails a certain restriction on the structure of \( p(a,e) \). In particular, the concavity of \( p(a,e) \) is strict but limited. Note that, in reality, \( p(a,e) \) may take be either concave or convex.
effects of punishment on crime and avoidance would change in size only, but not in direction. The cross-effects between crime and avoidance, however, would also depend on the sign of $p_{ae}(a,e)$. It seems reasonable to assume $p_{ae}(a,e) \leq 0$, which means that greater crime increases the effectiveness of investing in avoidance, or at least does not impair it. Then, crime and avoidance would still be complementary. Accordingly, the results of this paper follow through.

Cost of Avoidance Depends on Crime Level: According to the model, the costs of avoidance are independent of the crime level, i.e., fixed. However, this limiting assumption is not crucial for the results. Alternatively, the cost of avoidance can be assumed to increase in both the levels of crime and avoidance. Formally, replace the cost of avoidance in (3) with a general cost function $l(a,e)$, where $l_a(a,e) > 0$, $l_e(a,e) > 0$, and $l_{ae}(a,e) \leq 0$. Punishment still directly affects crime and avoidance in opposite ways, and as long as they are complements, crime may still rise and avoidance may still fall with increased punishment. Crime and avoidance become substitutes or independent under very specific condition, i.e., for sufficiently high $l_{ae}(a,e)$ (or low

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29 Formally, the complementarity between crime and avoidance holds for $H_{ae}(a^*,e^*) = -p_e(a^*,e^*)f_a(a^*,\beta) - p_{ae}(a^*,e^*)f(a^*,\beta) > 0$ (or correlative, if the following elasticity measure $-\frac{p_{ae}(a^*,e^*)}{p_e(a^*,e^*)} \frac{f_a(a^*,\beta)}{f(a^*,\beta)}$ is less than 1), which clearly holds for $p_{ae}(a^*,e^*) \leq 0$ and for $p_{ae}(a^*,e^*) > 0$ if its magnitude is sufficiently small. A complete formal proof is on file with the authors.

30 A negative sign may represent a certain kind of specialization of criminals in avoidance activities, or a fixed portion of investments in avoidance. A positive sign may denote "fatigue". Notice further that similar interpretation can be applied to $p_{ae}(a,e)$, only in effectiveness terms.

31 For example, even when each unit of crime requires certain amount of avoidance units – i.e. $l(a,e) = Qae$ (where $Q$ is a constant) – crime and avoidance are still complements, as long as $f_a(a) > \frac{f(a)}{a}$, which is so for a marginally increasing punishment schedule for crime.
Clearly, if additional avoidance becomes much costlier at a higher crime level, complementarity may not persist.33

Avoidance Consumes Real Resources: According to the basic model, avoidance is assumed not to consume resources (effort, time or alternatively wealth) that are subject to the budget constraint. This can be justified if the time spent on avoidance is negligible in relation to that invested in legal and illegal activity. Relaxing this assumption, however, does not change the qualitative results of the model. The direct effects of punishment on crime and avoidance do not change. The cross-effect between crime and avoidance, however, becomes unclear. Avoidance and crime are complements in the production of net punishment, but since they both compete for the same resource (time), they sustain a feature of substitution as well. Hence, overall, avoidance and crime can be complements, substitutes, or independent. As long as avoidance and crime remain complementary, our results carry over, otherwise, common intuition holds.34

Avoiding Punishment: The model assumes that avoidance affects the probability of punishment. Yet, avoidance might also affect the magnitude of punishment. An offender can conceal assets in order to constrain the potential effective fine, consume lavishly, or can invest in ways that might affect the sentencing decision, e.g., by contributing to charities or volunteering in public projects. Indeed, certain avoidance expenditures may affect both the probability and magnitude of punishment, such as creating alibis or investing in litigation.

32 At this point, for example, Stanley (1995) got it wrong. The results are not dependent on avoidance costs being fixed by the crime level.
33 Formally, the complementarity between crime and avoidance holds for
\[ H_{ae}(a^*, e^*) = -l_{ae}(a^*, e^*) - p_c(a^*, e^*)f_a(a^*, \beta) > 0, \]
which holds for \( l_{ae}(a^*, e^*) \leq 0 \) or even for \( p_c(a^*, e^*) \geq 0 \) if its magnitude is sufficiently small. A complete formal proof is on file with the authors.
The qualitative results of this paper, however, are the same if avoidance affects the severity rather than the probability of punishment. The key point, again, is that greater punishment leads to more avoidance, and avoidance and crime might still be complements. Revise the model in (3) so that investment in avoidance, \( e \), reduces the size of punishment (with or without affecting its probability). Assume that the technology of avoidance would exhibit diminishing marginal returns. Formally, assume that \( f(a,e,\beta) \), with \( f_e(a,e,\beta) < 0 \) and \( f_a(a,e,\beta) > 0 \). It can be easily verified that the direct effects of a change in punishment are similar for \( f_{eb}(a^*,e^*,\beta) \leq 0 \). The cross-effect between crime and avoidance depends on the sign of \( f_{ae}(a^*,e^*,\beta) \): the way investment in avoidance affects the marginal punishment of crime. Complementarity holds if \( f_{ae}(a^*,e^*,\beta) \leq 0 \), which is a reasonable assumption.

**Avoidance Measures:** According to the simplest interpretation of the model, \( e \) is the avoidance effort undertaken in the early stages of crime and \( p(e) \) is the probability of

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34 Formal proof is provided in the Appendix.

35 As Becker and Ehrlich (1972) put it, punishment-reducing measures can be termed self-insurance, and probability-reducing avoidance is self-protection.

36 The model can also sustain two kinds of investment in avoidance: \( e_1 \), affecting the probability of punishment, and \( e_2 \), affecting its magnitude. The results in this case still follow through, but \( e_1 \) and \( e_2 \) are substitutes. Nussim and Tabbach (2007b) examine a model of multiple avoidance activities.

37 Actually, the positive correlation between punishment and investment in avoidance remains as long as

\[
-\frac{f_{eb}(a^*,e^*,\beta)}{f_{e}(a^*,e^*,\beta)} \frac{p_e(e^*)}{p(e^*)} < 1,
\]

which holds for positive but sufficiently small \( f_{eb}(a^*,e^*,\beta) \).

38 Formally, the complementarity between crime and avoidance holds for

\[
H_{ae}(a^*,e^*) = -p_e(a^*,e^*)f_e(a^*,\beta) - p(a^*,e^*)f_{ae}(a^*,\beta) > 0 \quad \text{(or correlatively, if the following elasticity measure}
\]

\[
-\frac{f_{ae}(a^*,e^*,\beta)}{f_{e}(a^*,e^*,\beta)} \frac{p_e(e^*)}{p(e^*)}
\]

\[
\quad \text{is less than 1), which clearly holds for}
\]

\[
f_{ae}(a^*,e^*,\beta) \leq 0 \quad \text{and for } f_{ae}(a^*,e^*,\beta) > 0 \quad \text{if its magnitude is sufficiently small. Complete formal proof is on file with the authors.}
punishment. However, the model can be interpreted more generally. Thus, \( e \) may denote
the avoidance measure taken at any stage of criminal enforcement and \( p(e) \) the
probability that the offender would lose at this stage. For example, let \( e \) denotes
litigation expenses, and \( p(e) \) the probability of conviction (for any probability of
detection, apprehension and punishment). Formally, litigation expenses are similar to
investing in avoidance in the later stages, when the informational set changes (i.e., the
probability of punishment is different).\(^{39}\) Thus, avoidance and litigation effort are
substitute inputs in the offender's production function for crime. Thus, punishment can
easily be shown to have similar (direct and indirect) effects on investment in litigation,
and hence the results of the model are similarly applicable to this case.\(^ {40} \) Actually, the
model can be extended simply to include other avoidance measures at various stages of
the criminal process with corresponding probabilities.\(^ {41} \)

**Risk Preferences:** So far, offenders were assumed to be risk-neutral. This is
reasonable with respect to some offenders, such as firms, or in certain situations
involving small losses in relation to assets. However, in certain situations risk-neutrality
is not an adequate assumption. In particular, if losses are large relative to assets, or for

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39 Explicitly, the model in (3) would be rewritten \( EW = w(a) + c(a) - q[e - p(e)f(a, \beta)] \), where \( q \)
is the given probability of detection and apprehension. In this case \( e \) can represent litigation effort and
\( p(e) \) the probability of punishment. Alternatively, \( q \) may denote the probability of detection, and then
\( p(e) \) the probability of apprehension and \( e \) implies the cost of escaping.

40 Accordingly, various analyses of avoidance behavior are equally relevant to the analysis of the offender's
litigation effort. For example, analysis of avoidance as being subject to the resource constraint follows
although the litigation effort is considered part of the budget constraint. Similarly, the consequences of a
model in which the detection probability depends on both avoidance and crime would be similar if the
probability of conviction depends on both litigation effort and crime.

41 See also Wolpin (1978), Schmidt and Witte (1984). For a different analysis of multiple avoidance
measures, see Nussim and Tabbach (2007b).
criminal offenders. The main results of this paper, however, do not change qualitatively with non-neutral risk attitudes, although the offenders' optimization processes, equilibria and the model mechanics certainly differ.

The effects of increasing punishment on crime can still be analytically separated into direct and indirect. Consider first the direct effect of increased punishment on criminal activity. Risk-averse offenders would tend to reduce their criminal activity since not only do the expected costs of crime increase, but also the risks involved. The same effects can explain why risk-seeking offenders have an ambiguous response: while lower expected costs are detrimental, higher risk is beneficial. The direct effect of greater punishment on avoidance is different. Higher punishment increases the marginal utility of income of risk-averse offenders in the "bad" state of the world (i.e., under punishment), thereby making avoidance more costly in this state. However, since the expected costs of crime rise, the marginal benefit of avoidance increases. Thus, the total direct effect of changes in punishment on avoidance is ambiguous. Risk-seeking offenders, however, would unambiguously choose to increase their investment in avoidance, since greater punishment reduces the marginal utility of income in the "bad" state of the world, which, in turn, reduces the utility costs of avoidance.

The indirect effects are due to cross-dependency between crime and avoidance and partly depend on risk attitudes. Crime and avoidance are complements for both risk-averse and risk-seeking offenders in terms of benefits. This means that a higher crime level increases the marginal benefit of spending on avoidance, and vice versa. However, the relationship between crime and avoidance in terms of costs is not clear. A higher level of crime implies that the costs of investing in avoidance, in utility terms, are lower
(higher) in the 'good' state of the world, but are higher (lower) in the 'bad' state of the world, for risk-averse (risk-seeking) offenders. Thus, criminal activity and avoidance can be complements, substitutes, or independent for risk-averse or risk-seeking offenders.

**Participation Decisions and Heterogeneity:** The present model, like most portfolio models, concentrates on a representative offender who combines legal and criminal activities. Thus, it ignores two potentially important features that may affect the aggregate crime level: (1) the participation (or specialization) question; and, more generally, (2) offenders' heterogeneity. These issues are discussed in turn.

The common assumption of an interior solution to the offender's problem does not allow for specialized behavior. However, the specialization option is interesting because specialized individuals may respond differently to marginal incentives (such as small changes in punishment), which, in turn, may affect the aggregate crime level. A model allowing for specialization must also take different types of individuals into account.

Therefore, it is convenient to separate offender types into three sets: those who specialize in legal activity, those who specialize in crime, and those who combine legal and criminal activities ("mixers"). Greater punishment would not affect those refraining from crime – they would remain specialized in legal activities. However, greater punishment may affect the crime level of those specializing in crime. By definition, this group cannot increase their aggregate level of crime, but might decrease it. Since greater punishment reduces offenders' expected utility, some criminals who now find

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42 This is clear since for \( f_{ab}(a, \beta) \geq 0 \), an increase in \( \beta \) does not affect the sufficient condition for specialization in legal activity: \( -w'(0) \geq c'(0) - p(e)f_a(0, \beta) \) for all \( e \).
specialization unattractive may decide to become "mixers".\textsuperscript{43} The reaction of (a representative) "mixer" was analyzed in the main model, and the crime level found to show a possible increase. This analysis ignores the possibility that "mixers" might choose to specialize: either by abandoning criminal activity completely, or by concentrating on it. Clearly, however, the aggregate effect on the crime level would depend on distribution of potential offenders and their reaction to increased punishment. Nothing in this model rules out the possibility that greater punishment would lead to a rise in the aggregate crime level. This point can be generalized for any heterogeneous model in this framework. In such models, offenders may vary in three attributes: productivity in legal, criminal and avoidance activities.\textsuperscript{44} A heterogeneous model would specify a distribution of types as a function of their triplet productivity. Thus, the optimal solution would vary with type, and the effect of changes in punishment, according to conditions (8) and (9), for each per-type optimum and triplet of productivity features. The aggregate reaction to punishment would also then depend on these parameters. To reiterate the main point: in a heterogeneous model, the perverse result of greater punishment leading to higher aggregate crime level is possible.

\textsuperscript{43} This is clear for $f_{\alpha\beta}(\alpha, \beta) \geq 0$, since an increase in $\beta$ may change the \textit{sufficient} condition for crime specialization, $-w'(1) < c'(1) - p(e)f_e(1, \beta)$ for all $e$ for which $-p'(e)f(1) \geq 1$.

\textsuperscript{44} Individuals may differ in their initial wealth as well. However, the model ignores any wealth effects.
Table 1 – The Effects of Increasing Punishment on Crime and Avoidance

<table>
<thead>
<tr>
<th></th>
<th>Direct Effect on Crime</th>
<th>Direct Effect on Avoidance</th>
<th>Cross–Effects</th>
<th>Total Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Model</td>
<td>↓</td>
<td>↑</td>
<td>Complements</td>
<td>↑</td>
</tr>
<tr>
<td>Risk Aversion</td>
<td>↓</td>
<td>↑</td>
<td>ambiguous</td>
<td>↑</td>
</tr>
<tr>
<td>Risk Seeking</td>
<td>↑</td>
<td>↑</td>
<td>ambiguous</td>
<td>↑</td>
</tr>
<tr>
<td>Crime Affects</td>
<td>↓</td>
<td>↑</td>
<td>Complements*</td>
<td>↑</td>
</tr>
<tr>
<td>Detection p(a,e)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoidance Consumes</td>
<td>↓</td>
<td>↑</td>
<td>complements**</td>
<td>↑</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoiding Punishment f(a,k,β)</td>
<td>↓</td>
<td>↑</td>
<td>Complements***</td>
<td>↑</td>
</tr>
</tbody>
</table>

* For $p_{ae} \leq 0$ or for $p_{ae} > 0$ and $-\frac{p_{ae}(a,e)}{p_{e}(a,e)} \left/ \frac{f_{e}(a,β)}{f(a,β)} \right. < 1$. (See Appendix.)

** For $w''(1-a^* -e^*) > p''(e^*)f_{e}(a^*,β)$. Otherwise, they are substitutes or independent. (See Appendix).

*** For $f_{iu}(a,k,β) < 0$. (See Appendix).

5. ALTERNATIVE POLICY TOOLS

This paper has been dealing so far with the positive effects of one enforcement tool: punishment. However, policy-makers generally consider other policy tools, such as enforcement efforts, work subsidies, job training, rehabilitation, and so on. All enforcement tools are directed at changing the relative prices of legal and illegal activities, making the latter less attractive. Increasing punishment or tightening the enforcement effort increases the price of illegal activity. Subsidizing legitimate alternatives to crime reduces the price of legal activity (i.e., increases the opportunity costs of crime).

This Section examines how other policy tools at the disposal of the policy-maker affect crime and avoidance. Increased enforcement efforts may also counter-intuitively
increase crime and avoidance, but can also potentially decrease avoidance directly. In addition, programs aimed at increasing the opportunity costs of crime do not directly induce avoidance, thereby providing additional benefit, which have been overlooked so far.\textsuperscript{45}

\textit{A. Enforcement Effort}

Assume that the probability of detection depends on offender’s expenditures on avoidance and the public enforcement of detection (or conviction) effort. Assume also that the probability of detection increases with enforcement effort in decreasing rates. Formally, \( p(e,m) \), where \( m \) stands for the public enforcement effort.\textsuperscript{46} Consider the effects of increasing enforcement effort. Enforcement effort may affect the size of the cross-effect between crime and avoidance but not its direction. Hence, they remain complements. In addition, improved enforcement effort clearly increases the marginal cost of crime, thereby directly reducing the crime level. The direct effect of enforcement effort on avoidance, however, depends on its technology; more precisely on its effects on the marginal effectiveness or benefits of private avoidance, formally, on the sign of \( p_{me}(e,m) \).

By and large, the sign of \( p_{me}(e,m) \) in reality is not clear. Counter-measures by offenders reacting to increased public enforcement effort are not uncommon, e.g., radar detectors as a counter-measure to radar guns, sophisticated tax schemes as a counter-measure to new tax regulations (enforcement), novel techniques of smuggling to counter

\textsuperscript{45} Once the economic model of crime accounts for offenders' choice of avoidance, rather than crime only, controlling avoidance directly becomes another possible enforcement object. This paper focuses on the
drug/weapon detection methods, and so on. If \( p_{me}(e, m) < 0 \), then increased enforcement effort would lead to a direct rise of investment in avoidance. Then again, crime and avoidance are affected in opposite directions, and due to complementarity, crime may rise as well.

However, enforcement techniques might reduce the effectiveness of certain avoidance activities, or at least not affect them, i.e., \( p_{me}(e^*, m) \leq 0 \). Then, either there is no direct effect on avoidance or avoidance is directly reduced. Due to complementarity, both avoidance and crime would definitely fall.

Therefore, taking into account offenders' avoidance activities, enforcement efforts may be preferable and more effective in fighting crime than punishment, although they might be more costly in social terms. Using the appropriate enforcement technology, i.e., with \( p_{me}(e^*, m) \leq 0 \), both crime and wasteful investment in avoidance are reduced, whereas greater punishment may achieve the opposite effect.48

B. Subsidizing Legal Alternatives

A third social instrument in fighting crime is by increasing its opportunity costs, e.g., work subsidies, job training, education or vocational programs, and, more generally,
subsidizing legitimate alternatives. Traditionally, a distinction is made between programs targeted at ex-convicts, which usually come under the rubric of rehabilitation programs, and programs or subsidies offered to the general public. Rehabilitation is considered problematic because it might dilute the sting of punishment, since it confers an implicit subsidy on potential offenders by offering training and other benefits at the public expense. As such, rehabilitation may have a counter-deterrent effect on potential offenders \textit{ex ante}.\footnote{In addition, even if rehabilitation programs work on an individual level, they do not necessarily affect the aggregate crime. On these two points, see Ehrlich (1981).} Under this model, this would lead to similar effects as reducing punishment.\footnote{Note that the model adopted here is static rather than dynamic. Positive effects of rehabilitation on both the future crime level and avoidance might occur in a dynamic crime model.}

Programs aimed at the general population can also be counter-productive since they might increase not only the returns from legal endeavors but also those from criminal activities.\footnote{Consider education programs for mastering computers, which not only increase potential benefits of legal endeavors, but also from criminal computer-related crimes.} However, the present analysis suggests that such programs, to the extent that they directly decrease criminal activity, are preferable to traditional punishment. This fact has been overlooked so far.\footnote{Strictly speaking the present analysis deals with programs aimed at the general public, which increase the opportunity costs of crime only. Nevertheless, rehabilitation programs would enjoy a similar benefit, both with respect to future crime and avoidance, which is not formally modeled here.} For simplicity, consider programs aimed at all potential offenders, such as subsidizing legal alternatives. Crime is presumably directly reduced by such measures since its expected marginal gain goes down relative to that of its substitutes, i.e., legal activities. However, the marginal benefit effectiveness or benefit of avoidance. A similar analysis can be applied to the case of avoiding punishment magnitude.
of avoidance, which is unrelated to its effectiveness, is unaffected by them. Hence, there is no direct effect on avoidance.\footnote{Formally, assume $w(a, \gamma)$, where $\gamma$ denotes investment in public programs, and $w_e(a, \gamma) > 0$. $w_a(a, \gamma) < 0$. Optimizing offenders choice of $a^*$ and $e^*$, and them implicitly differentiating with respect to $\gamma$, it can be easily proved that both crime and avoidance are reduced with higher $\gamma$. Crime is directly reduced, and avoidance is indirectly reduced via its complementarity with crime.}

In addition, crime and avoidance remain complements since the effect of each on the other's marginal benefit/cost is unrelated to the opportunity costs of crime. Thus, increasing the opportunity costs of crime directly reduces it, while indirectly reducing avoidance activity. Although more costly than punishment, this may prove to be a better social tool for fighting crime if avoidance is significant.\footnote{Formally, assume $\gamma$, where $\gamma$ denotes investment in public programs, and $0, \gamma > 0, \gamma aw$. Optimizing offenders choice of $a^*$ and $e^*$, and them implicitly differentiating with respect to $\gamma$, it can be easily proved that both crime and avoidance are reduced with higher $\gamma$. Crime is directly reduced, and avoidance is indirectly reduced via its complementarity with crime.} Furthermore, compared to enforcement effort, increasing the opportunity costs of crime may prove superior or inferior, depending on the enforcement effort and avoidance technology. Comparing, for example, rehabilitation and monitoring, $\$1$ with the same direct effect on crime (i.e., similar increase on the marginal costs of crime) may prove superior in the latter case.

Tailored enforcement effort can fight both crime and avoidance, thus making the social measure more effective.

6. CONCLUDING REMARKS

This paper examines the effects of public enforcement tools, in general, and punishment, in particular, on crime level when offenders can engage in avoidance activities. Three elements are identified, the combined effects of which determine the total effect of various policy tools on crime: the common direct effects on crime and avoidance, and the indirect effect between crime and avoidance, which has been largely
neglected to date. The key insight is that crime and avoidance are generally complements, in the sense that increased crime leads to greater avoidance, and vice versa.

This complementarity leads to several interesting and counter-intuitive results. In contrast to common intuition, this analysis shows that increased punishment for crime neither increases deterrence nor induces avoidance necessarily. Owing to this complementarity, more severe punishment may result in increased crime or in less avoidance, but not both. Similarly, depending on the enforcement and the avoidance technologies, tighter enforcement does not necessarily decrease criminal activities. In addition, this paper shows that programs aimed at increasing the opportunity costs of crime, such as subsidizing legal alternatives to crime, reduce criminal activity because they do not directly induce avoidance. Indeed, such programs may also dampen avoidance because crime and avoidance are complements.

We believe that the analysis and examples in this paper are not mere curiosities, but may have some empirical explanatory power. The growing number of empirical studies on crime enforcement does not reveal a consistent and significant deterrence effect. In particular, although the effects of enforcement efforts on crime are usually negative and significant across different studies, the effect of punishment is not. Several empirical studies examining the effect of punishment on various criminal offences and using different valuation methods are not conclusive. Indeed, some studies do not find any negative effect of punishment; while others describe a small negative effect, which is

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54 Clearly, if such programs directly increase the attractiveness of criminal activities (see supra, note 52), then avoidance would actually increase due to complementarity.
not always statistically significant.\textsuperscript{55} Moreover, anecdotal evidence also supports this analysis.\textsuperscript{56}

In addition, the analysis in this paper provides important insights for policy-making and enforcement-policy design. As stressed by Malik (1990), if avoidance is possible, the enforcement system has two functions: optimizing deterrence and minimizing wasteful avoidance activity. This paper implies that optimizing the enforcement system requires several refinements, which depend significantly on the interrelation between avoidance and crime and the avoidance technology, among other factors.

First, due to the cross-effects between crime and avoidance, the extent of the direct effects of punishment on the levels of crime and avoidance are extremely important. Since the direct effect on crime depends on the marginal sanction while the direct effect on avoidance is related to the total sanctions, the ratio of the marginal to the total expected punishment is critical in the design of punishment structure and sentencing guidelines.

Second, after recognizing the possibility of complementarity between crime and avoidance, the optimal enforcement reaction is no longer straightforward. In particular, in

\textsuperscript{55} See, for example, surveys by Eide (1994, 2004), Von Hirsch et al' (1999). Actually, there are a few empirical studies which find a positive relationship between crime and punishment. See Eide (2004). Take also, for example, the tax compliance empirical studies. Witte and Woodbury (1986) find that the probability of audits has a positive effect on compliance, but no significant relationship is found between sanctions and compliance. (They also disaggregate the probabilities of audit and punishment, and do not find any significant relationship between the latter and compliance.) Frey and Pommerehne (1992) and Pommerehne and Weck-Hannemann (1996) find a positive but insignificant effect of punishment on compliance. Experimental studies of tax compliance and penalties are inconclusive. Alm et. al. (1992), using laboratory experiments, find a positive effect of fines on taxpayers' compliance, which however, is very small and statistically almost insignificant. Bayer and Sutter (2004) report that the effect of fines on tax compliance is insignificant. Lastly, note that these studies commonly do not attempt to mark out the incapacitation effect from the deterrence effect, which still proves to be a difficult empirical task.
contrast to Malik's (1990) conclusion, punishment resulting in over-deterrence rather than under-deterrence might be optimal. This is because although greater punishment increases wasteful incentives to invest in avoidance, it also further deters crime, which indirectly renders avoidance less beneficial. The overall effect of over-deterrence on wasteful avoidance might be preferable.

Lastly, offenders' avoidance activities affect the relative efficacy of the various enforcement tools, which is important for the design of enforcement policy. For example, subsidized work, job training, and vocational programs may prove to be a superior policy tool when avoidance is important, even if it may require more social resources. Overall, although this paper does not directly examine normative implications of avoidance activities, it points out important components, considerations and directions for such analysis.

56 Stanely (1995a), for example, offers the use of radar detectors as an example of the possibility that higher sanctions would increase speeding.

57 It should be noted that this paper differs from Malik's paper in important ways. His crucial assumption, for our purposes, concerns offenders' choice of crime. He assumes that there is a binary choice – whether to participate in illegal activity of a specific degree or not. Changes in punishment may affect the offenders' participation (in crime) decision, but, by construction, cannot affect their crime levels. Thus, Malik's model implicitly discards the possibility of cross-effects between crime and avoidance, which is central to the present paper. If, and only if, individual participate in illegal activity, would he or she also invest in avoidance. Once an individual engages in crime, any change in punishment directly affects avoidance only. Allowing for continuous levels of criminal activity, rather than participation decision only, this paper reveals a neglected fault of Malik's model: higher punishment levels may actually reduce investment in avoidance. This, in turn, implies that optimal punishment may exhibit over-deterrence rather than under-deterrence (under Malik's model, over-deterrence is possible only as, a relatively uninteresting, corner solution). Moreover, although Malik does not examine explicitly the effects of increased punishment on crime, it should be clear that under his model, the crime level cannot rise. This obviously stands in sharp contrast to the main result in this paper. Note also that both Malik (1990) and Innes (2001) concentrate on normative rather than positive analysis. The latter does not analyze the effect of avoidance on criminal activity, but rather the effect of self-reporting on avoidance.
REFERENCES:


http://law.bepress.com/taulwps/art28


Nussim, Jacob Avraham Tabbach. 2006b. (Non)regulable Avoidance and the Perils of Punishment. working paper.


APPENDIX:

Section 5:

A. Enforcement Effort

Assume in (3) that the probability of punishment depends on private investment in avoidance as well as on exogenously given public enforcement effort – denoted $m$, and that $p_m(e, m) > 0$ and $p_{mm}(e, m) < 0$. The individual's maximization problem (3) is adjusted:

\[ (A8) \quad EW = W + w(a) + c(a) - e - p(e, m)f(a). \]

The conditions for an interior optimum do not change except for the probability of punishment being a function of $m$ as well.

Implicitly differentiating the optimal solution – $a^*$ and $e^*$ – with respect to $m$ (of the adjusted equations (4) and (5)) yields equations similar to (6) and (7) in which $m$ takes the place of $\beta$.

Assuming an interior solution exists, $H_{ae}(a^*, e^*) < 0$ and $H_{ma}(a^*, e^*) < 0$.

Additionally, it is clear that $\frac{\partial H_a(a^*, e^*)}{\partial m} = -p_m(e^*, m)f_e(a^*, \beta) < 0$, and

\[ H_{ae}(a^*, e^*) = -p_e(e^*, m)f_a(a^*, \beta) > 0 \] (a and e are complements). Thus, $\frac{da^*}{dm} > 0$ only if

\[ \frac{\partial H_a(a^*, e^*)}{\partial m} = -p_m(e^*, m)f(a^*, \beta) > 0, \]

which corresponds to $p_{em}(e^*, m) < 0$. That is, crime is directly reduced due to higher enforcement effort. However, if avoidance is induced as well by enforcement effort, than for strong enough effect on avoidance or strong enough complementarity, crime may be increased after all. For example, if
avoidance is not directly affected, i.e. \( p_{em}(e^*,m) = 0 \), then \( \frac{\partial H_e(a^*,e^*)}{\partial m} = 0 \) and \( \frac{da^*}{dm} < 0 \)

(and complementarity is irrelevant). Similarly, \( \frac{de^*}{dm} < 0 \), if \( \frac{\partial H_e(a^*,e^*)}{\partial m} \leq 0 \) – that is, when \( p_{em}(e^*,m) \geq 0 \). Notice that this result is kind of obvious: \( p_{em}(e^*,m) > 0 \) indicates that larger public enforcement effort reduces the marginal effectiveness of avoidance, and hence directly reduces the incentives to avoid. It can be added, according to the model, that since crime is also directly reduced, complementarity only reinforces the influence of enforcement effort on both crime and avoidance. Yet, a more interesting result is the possibility of \( \frac{de^*}{dm} < 0 \) even when \( \frac{\partial H_e(a^*,e^*)}{\partial m} > 0 \). That is, though \( p_{em}(e^*,m) \) is negative (as long as it is not excessively negative), higher public enforcement effort may still reduce offenders' optimal choice of avoidance – \( e^* \). This result is interesting since the direct effect of larger enforcement effort when \( p_{em}(e^*,m) < 0 \) is to increase private investment in avoidance. Hence, this result is due to the complementarity with criminal activity. That is, even when the technology of enforcement effort directly induces avoidance, a strong deterrence effect may indirectly discourage avoidance as well.
Avoidance Consumes Real Resources: Revise the model in (3) by assuming
\( w(1-a-e) \), and \( w'(1-a-e) > 0 \), \( w''(1-a-e) < 0 \). The first order conditions for maximum become:

\[
(A1) \quad H_a = -w_a (1-a-e) + c'(a) - p(e) f'(a, \beta) = 0
\]

\[
(A2) \quad H_e = -w_e (1-a-e) - p'(e) f(a, \beta) - 1 = 0
\]

Differentiating the optimal solution – \( a^* \) and \( e^* \) – using implicit differentiation yields equations (6) and (7).

Assuming an interior solution, \( H_{ae}(a^*, e^*) < 0 \) and \( H_{ae}(a^*, e^*) < 0 \). Additionally,

\[
\frac{\partial H_a(a^*, e^*)}{\partial \beta} = -p'(e) f'(a, \beta) > 0; \text{ and reasonably assuming } f_{a\beta}(a^*, \beta) \geq 0, \text{ implies }
\]

\[
\frac{\partial H_a(a^*, e^*)}{\partial \beta} \leq 0. \text{ Thus, } \frac{da^*}{d\beta} > 0 \text{ or } \frac{de^*}{d\beta} < 0, \text{ only if }
\]

\[
H_{ae}(a^*, e^*) = w''(1-a^*-e^*) - p'(e^*) f_a(a^*, \beta) > 0. \text{ The second term of }
\]

\( H_{ae}(a^*, e^*) \) indicates the complementarity between crime and avoidance through their opposite effect on expected punishment. The first term represents the substitutability of crime and avoidance because they both deep into the same pool of resources. The extent of their substitutability depends on the rate of decrease in the return to legal activity with any additional resource unit consumed in crime or avoidance.

Risk Preferences: The model is next analyzed under non-risk-neutral preferences.
deterrence or encourage avoidance due to the complementarity between crime and avoidance. To see this, focus first on risk-averse offenders. Derive the first order conditions of (1) in respect to $a$ and $e$:

\[(A3) \quad \frac{\partial E[U(a,e)]}{\partial a} = H_a(a,e) = p(e)U'(Y)Y_a + (1 - p(e))U'(X)X_a = 0\]

\[(A4) \quad \frac{\partial E[U(a,e)]}{\partial e} = H_e(a,e) = p'(e)U(Y) - p(e)U'(Y)(1 - p(e))U'(X) = 0\]

where $X_a = w'(a) + c'(a) > 0$ and $Y_a = w'(a^*) + c'(a^*) - f_a(a^*, \beta) < 0$.\(^{59}\)

Denote the optimal interior solution by $a^*$ and $e^*$. Differentiating the optimal solution with respect to $\beta$ yields equations (6) and (7). The assumption of an interior solution guarantees that $H_{aa}(a^*, e^*) < 0$ and $H_{ae}(a^*, e^*) < 0$. Notice also that:

\[(A5) \quad \frac{\partial H_a(a,e)}{\partial \beta} = p(e)U'(Y)\left[\frac{U'(Y)}{U'(Y)}Y_\beta + Y_{a\beta}\right] = p(e)U'(Y)\left[-R_\beta(Y)Y_\beta + Y_{a\beta}\right]\]

\[(A6) \quad \frac{\partial H_e(a,e)}{\partial \beta} = U'(Y)\left[p'(e)Y_\beta - p(e)\frac{U'(Y)}{U'(Y)}Y_\beta\right] = U'(Y)\left[p'(e)Y_\beta + p(e)R_\beta(Y)Y_\beta\right]\]

where $R_\beta(\cdot) = \frac{U'(\cdot)}{U''(\cdot)}$ denotes Arrow-Pratt absolute risk-aversion measure;

$Y_\beta = -f_\beta(a, \beta) < 0$, and assuming $f_{a\beta}(a, \beta) \geq 0$, $Y_{a\beta} = -f_{a\beta}(a, \beta) \leq 0$. Hence

\(^{58}\) Without loss of generality, it is assumed that $a$ and $e$ are measured in identical units, and hence $w'(1 - a - e) = w_a(1 - a - e) = w_e(1 - a - e)$.

\(^{59}\) Notice that under risk-neutrality, $-w'(a^*) = c'(a^*) - p(e^*)f_a(a^*, \beta)$ (see equation (4')). Accordingly, risk-aversion requires $-w'(a^*) \geq c'(a^*) - p(e^*)f_a(a^*, \beta)$, which in turn implies $w'(a^*) + c'(a^*) - f_a(a^*, \beta) < 0$.\(^{59}\)
\[ \frac{\partial H_at(a,e)}{\partial \beta} < 0 \text{ for risk-averse offenders; } \frac{\partial H_at(a,e)}{\partial \beta} < 0 \text{ only for high enough degree of risk-aversion; otherwise, } \frac{\partial H_at(a,e)}{\partial \beta} \geq 0. \]

Lastly, note that crime and avoidance may still be complements. Examine:

\begin{align*}
(A7) \quad \frac{\partial E[U(\cdot)]}{\partial a e} &= H_{ae}(a,e) = p'(e)[U'(Y)Y - U'(X)X_a] - p(e)U'(Y)Y_a - (1 - p(e))U'(X)X_a
\end{align*}

using \( X_a = -Y_a \frac{p(e)}{1 - p(e)} \frac{U'(Y)}{U'(X)} \) from the first order condition (A3) and the Arrow-Pratt measure of absolute risk-aversion, equation (A7) can be rewritten as:

\begin{align*}
(A7') \quad H_{ae} &= \frac{p'(e)}{1 - p(e)} U'(Y)Y_a - p(e)U'(Y)Y_a [R_A(X) - R_A(Y)].
\end{align*}

The first term is positive, and the sign of the second term depends on the structure of risk-aversion. If offenders exhibit constant absolute risk-aversion, the second term zeros out, while for decreasing absolute risk-aversion, the second term is negative. Thus, as long the offenders' absolute risk-aversion is increasing, constant, or not decreasing too rapidly, \( H_{ae} > 0 \) - i.e. crime and avoidance are complements.

Thus, looking at equation (6), three sufficient conditions generate the outcome of rising crime with higher punishment: (i) offenders exhibit increasing, constant, or mildly decreasing absolute risk-aversion (i.e. crime and avoidance are complements); (ii) the degree of absolute risk-aversion (in the optimum) is not excessively high; (iii) complementarity is strong enough or the degree of risk aversion is low enough.\(^{60}\)

\(^{60}\) Notice that equation (6) yields another interesting result. If absolute risk-aversion is falling rapidly – i.e. crime and avoidance are substitutes – then for sufficiently high degree of absolute risk-aversion (in the
Similarly, examining equation (7), two sufficient conditions generate the outcome of discouraged avoidance with higher punishment: (i) complementarity (as above); and (ii) high enough degree of absolute risk-aversion (in the optimum).

Participation Decisions and Heterogeneity: An Illustration

Assume that all individuals are identical in their legal and illegal productivity and differ in their avoidance function. Specifically, denote individuals’ type by $t$, and assume the probability of detection function is $p(e,t) = \frac{\delta}{\alpha} + t$, where $\alpha > 1$ is any real number, $0 < \delta \leq 1$, and $-\frac{\delta}{\alpha} < t < 1 - \frac{\delta}{\alpha}$. Under these assumptions the LHS of (8) is smaller (larger) then 1 for any negative (positive) $t$. Assume a punishment structure – $f(a, \beta) = \beta f(a)$, where $\beta > 1$ – that yields a RHS of (8) equal to 1. Now, if, for further simplicity $t$ is assumed to distribute uniformly, the aggregate crime reaction to changes in punishment depend on the specification of the detection probability (i.e. $\delta$ and $\alpha$) and the optimal solution (i.e. $e^*$). For example, assuming $\frac{\delta}{\alpha} = \frac{1}{2}$, an equal proportion of offenders increase and decrease their crime level in reaction to higher punishment.

Accordingly, if $\frac{\delta}{\alpha}$ is smaller (larger) then half, a larger (smaller) proportion of offenders would increase their criminal activity in reaction to higher punishment.

(optimum), crime is also rising with higher punishment. The reason for that result is that high degree of risk aversion brings avoidance down also (see explanation at —Section 4), and thus only if crime and avoidance are substitutes, this result is possible.