On the Ambiguous Effects of Repression

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Abstract

The purpose of this note is to investigate the optimal enforcement of the penal code when criminals invest in a specific class of avoidance activities termed *dissembling activities* (i.e. self-protection efforts undertaken by criminals to hedge their illegal gains in case of detection and arrestation). We show that the penal law may have two different screening effects: it may separate the population of potential criminals between those who commit the crime and those who do not, and in the former group, between those who undertake dissembling efforts and those who do not. Then, we show that it is never optimal to use less than the maximal fine in contrast to what may occur with avoidance detection (i.e. efforts undertaken in order to reduce the probability of arrestation: Malik [1990]); and furthermore, that the optimal penal code may imply overdeterrence. Finally, we show that any reform of the penal code has ambiguous effects when criminals undertake dissembling activities which are a by-product of illegal activities, since increasing the maximum possible fine may increase or decrease the number of crimes committed and may increase or decrease the proportion of illegal gains hedged by criminals.

Keywords: deterrence, dissembling activities, optimal enforcement of law.

JEL Classification: D81, K42.

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1 Introduction

The canonical economic literature on crime and punishment initiated by Becker [1968] has provided two classical results. On the one hand, the best trade-off between probability and penalty is achieved when monetary penalties are set to their maximum possible level, because fines are most of the time costless, allowing the enforcement authority to set them as high as possible. On the other hand, it is not optimal to completely deter individuals from engaging in an illegal activity, since for at least some individuals, the gains from engaging in the proscribed activity may be sometimes larger than the external costs it imposes on the rest of the society. The first result has prompted a large body of literature (see Garoupa [1997] or Polinsky and Shavell [2000] for surveys) discussing cases where fines are costly resources for enforcers or for the criminals, hence justifying that less than maximum fines be used. In contrast, the second result is a common by-product of the former, and it has been shown that whenever enforcement authorities have imperfect information about criminals' activities and/or their characteristics, the optimal design of the penal code allows some level of underdeterrence to exist.

Following this line, we tackle in this note two commonly acknowledged results: on the one hand the fact that avoidance activities undertaken by criminals are a major reason justifying the optimality of less than maximum fine (Bebchuk and Kaplow [1993], Langlais [2008], Malik [1990],), and on the other hand, that such activities aggravate the issue of criminals' underdeterrence (Sanchirico [2006]). In contrast, we will prove first that for the specific class of avoidance activities that we term dissembling activities, it is never optimal to use less than maximum fines. Second, we will also show that public policies designed to prevent criminal behavior may lead to overdeterrence, in the sense that some offenders are deterred from engaging in the illegal activity although their private benefit is larger than the external cost they impose on the rest of the society.

Avoidance activities encompass various expenditures engaged by criminals in order to reduce their exposure to the risk of punishment. It comprises installing radar detectors to avoid speeding tickets, lobbying politicians to relax the enforcement of regulations, bribing an enforcement agent to let go free a culprit, destroying or covering up incriminating evidences, or investing in long and costly litigations and so on. Thus, we suggest a basic albeit more comprehensive typology similar to the distinction made in the economics of insurance markets, between self-protection and self-insurance. In fact, some avoidance activities are undertaken in order to lower the probability of apprehension, conviction and/or punishment. Typically, this is the case for example with radar detectors. Note that such expenditures may be understood as self-protection investments from the point of view of criminals (they are more specifically termed avoidance detection by Sanchirico [2006]). But the rationale for other kinds of avoidance activities is in contrast to reduce the impact of the arrestation and punishment on the wealth or welfare of the criminals: typically, it occurs when criminals are strategically bankrupt or non solvable, as it is the case when they render non

seizable the benefits of the crime. In this case, it corresponds for the criminals to a kind of self-insurance behavior that will be termed dissembling activities in the paper.

In fact, the existing literature on avoidance activities focuses on the case of detection avoidance. SANCHIRICO [2006] has recently suggested that it is a serious limit to the effectiveness of public policies in the area of crime deterrence. He argues that it implies the unfortunate but unavoidable result that any increase in public monitoring expenditures leads to an increase in criminals' avoidance activities, which in turn has an adverse feedback effect on the effectiveness and efficiency of public detection, thruly leading to a high level of underdeterrence. Nevertheless, Sanchirico does not address the issue of the optimal probability/fine trade-off. Such an analysis has been earlier provided by MALIK [1990] and BEBCHUK and KAPLOW [1993] who have shown that avoidance detection may justify that less than maximum fines are optimal[1]. Here, we focus on dissembling activities, assuming that criminals' investments in order to avoid the risk of punishment enable them to hedge their illegal benefits in case of arrestation, allowing the enforcer to seize only a small amount of those outcomes.

Section 2 describes the basic set up used in the paper, and proves that the penal code may have two different screening effects, depending on the marginal productivity of dissembling efforts. When it is low enough, the population of offenders separates in three groups, between those who commit the crime and those who do not; on the other, it also distinguishes among the active criminals between those who undertake dissembling efforts and those who do not. In contrast when the marginal productivity of efforts is high enough, the population separates between those who commits the crime and make an effort, and those who are deterred. In the rest of the paper, we show that the way the population separates introduces only minor consequences for the influence of the penal code when dissembling efforts are taken into account. In section 3, we show that the beckerian result, namely the optimality of maximum fines, still holds here. However, and in contrast to what occurs in Becker's paper„ overdeterrence may now occur at the optimum. Section 4 focuses on the effectiveness of public interventions. We first show that monetary penalties and the probability of control may be either substitutable or complementary instruments. This implies that when enforcement policies become more repressive, criminals may take countervailing decisions which result in more crimes, more individuals making dissembling efforts and saving a larger proportion of their illegal benefits in case of arrestation. Finally, this means also that the reform of the penal code has ambiguous effects on criminality: in the situation where underdeterrence exists at the optimum, the distortion from the first best may be reduced as the maximal level of fine increases (for example, with the seizable wealth or assets of criminals) since the optimal level of deterrence goes closer to the external cost of crimes: public policies become thus more efficient. On the contrary, in the case where overdeterrence occurs at optimum, then the distortion with respect to

[1] See also NUSSIM and TABBACH [2007].

the first best may be aggravated as the maximal possible fine is raised, making the level of deterrence closer to full deterrence. Section 5 briefly concludes.

2 Criminals' behavior

Let us consider the case where the illegal activity allows the (risk neutral) criminal to obtain a benefit equal to b (and $b = 0$ if the illegal act is not undertaken) which will be called the type of the criminal. Public authorities do not observe the type b. They just know that b is distributed according to a uniform distribution function on[2] $[0, B]$. On the other hand, the (external) loss to the rest of the society is $D < B$ in case of crime, whatever the private benefit for the criminal[3]. We consider here that public enforcers are endowed with two basic instruments, as is usual in the literature: monetary sanctions (penalty or fine) $f > 0$, and expenditures in the monitoring of criminals' behavior, defined for the sake of simplicity as the choice of a probability of control p (encompassing arrestation, conviction and punishment for an illegal behavior).

When he is caught, the offender has to pay the fine but the protective measures undertaken *ex ante* allow him to save a fraction $\beta(x) \in]0, 1[$ of his benefit b, where x denotes his effort in the dissembling activity (caution). We assume that: $\beta(0) = 0$; $\beta' > 0$, where $\beta'(0) > 0$ and is finite, albeit $lim_{x\to\infty}\beta'(x) \to 0$; and finally $\beta'' < 0$. Furthermore, we assume that the monetary equivalent of the disutility cost of criminal's efforts is simply $v(x) = x$.The maximum expected benefit obtained by the criminal when he undertakes the illegal activity and makes the avoidance effort is equal to:

$$u \equiv \max_{x} (\pi(x, p)b - pf - x) \tag{1}$$

with $\pi(x, p) = 1 - p + p\beta(x)$, which may be understood as the *ex ante* total proportion of the illegal benefit saved by the offender[4]. The individually optimal behavior of a criminal is described by the following proposition, denoting $\hat{x}$ the efficient level of effort[5].

Proposition 1 *A) Assume that* $\beta'(0) < \frac{1-p}{p^2.f}$. *Then, the population of criminals separates in three different groups, defined according to two different thresholds labelled* $\bar{b}$ *and* b^**, such that:*

i) if the criminal's type is $b \in [0, \bar{b}]$*, then he does not commit the crime;*

ii) if the criminal's type is $b \in]\bar{b}, b^*]$*, then he does commit the crime but without undertaking any dissembling effort* ($\hat{x} = 0$)*;*

[2] Note that we assume that B is large enough, in order that any one of the thresholds of benefit defined hereinafter exists and is smaller than B.

[3] Thus as usual in the literature, the first best level of deterrence corresponds to the illegal benefit $b = D$ (assuming it can be obtained at a small enforcement cost). Given that the type of the criminals is not observable, it is generally never attainable.

[4] With probability $1 - p$, the criminal saves the benefit b in proportion 1, although with probability p he saves only $\beta(x) < 1$.

[5] All the proofs are in the appendix.

iii) if the criminal's type is $b \in]b^*, B]$*, then he does commit the crime and undertakes a positive level of effort* ($\hat{x} > 0$) *which satisfies:*

$$p\beta'(\hat{x})b = 1 \tag{2}$$

B) Assume that $\beta'(0) \geq \frac{1-p}{p^2 \cdot f}$*. Then, the population of criminals separates in two different groups, defined according to the threshold* $\bar{b}$ *such that:*

iv) if the criminal's type is $b \in [0, \bar{b}]$*, then he does not commit the crime;*

v) if the criminal's type is $b \in]\bar{b}, B]$*, then he does commit the crime and undertakes a positive level of effort* ($\hat{x} > 0$) *which satisfies condition (2).*

To sum up, $\bar{b}$ (the level of crime deterrence) reflects the likelihood of paying the fine f, whereas b^* reflects the marginal productivity of the investments in dissembling efforts.

Proposition 1 means that if $\beta'(0)$ is small enough, any enforcement policy has in fact two distinct screening effects on the population of potential criminals. On the one hand, it leeds to the separation between those who become active criminals, and those who are deterred - this a basic effect. The threshold $\bar{b} \equiv \frac{p}{1-p} f$ corresponds to the level of deterrence under which no crime is committed (this threshold increases both with f and p). But there exists a second effect: among the active offenders, some of them will also invest in dissembling activities (make some efforts to hedge their benefits in case of arrestation), while the others will not. Namely, $b^* \equiv \frac{1}{p\beta'(0)}$ is the threshold over which any crime committed is accompanied by an effort in dissembling activities (and it decreases with p but is independant of f). It is easy to see[6] that for any $b \in]b^*, B]$, the optimal $\hat{x} = x(p, b)$ is unambiguously increasing with p and b, but is independent from the fine. The value of the fine f matters only in the sense that it influences the decision to engage in the illegal activity or not, although it does not affect the decision to undertake or not the avoidance expenditures.

In contrast, when $\beta'(0)$ becomes large enough, we obtain that the population seperates between those who do not enter ($b \leq \bar{b}$), and those ($b > \bar{b}$) who enter and find beneficial to undertake an effort in dissembling activities.

The rest of the paper studies the effects of the optimal enforcement of the law, i.e. the choice of the optimal mix of instrumenys (p, f), on each specific structures of the population of criminals.

3 Second best policies

We assume that the management costs associated with the monetary penalty are neglectable, but that monitoring the criminal activity entails a cost equal to $m(p)$, with $m' > 0$ and $m'' > 0$.

[6] Applying the implicit function theorem to (2), one obtains: $\frac{\partial \hat{x}}{\partial p} = \frac{\beta'(\hat{x})}{-\beta''(\hat{x})p} > 0$ and $\frac{\partial \hat{x}}{\partial b} = \frac{\beta'(\hat{x})}{-\beta''(\hat{x})b} > 0$.

Let us first consider a case where the solution in (p, f) is consistent with the condition $\beta'(0) < \frac{1-p}{p^2.F}$. The government has to choose a fine f and a probability of control p in order to maximize the social welfare function[7]:

$$S = \frac{1}{B}\int_{\bar{b}}^{b^*}((1-p)b - D)db + \frac{1}{B}\int_{b^*}^{B}(\pi(x(p,b),p)b - x(p,b) - D)db - m(p) \quad (3)$$

under the constraint[8] $f \leq F$. The two first (integral) terms in S correspond to the expected private benefit associated with the illegal activity (the benefit of the criminal without dissembling efforts minus the external cost, plus his benefit when he commits the crime with a positive effort minus the cost of dissembling and the cost to the society). The last one is the cost of monitoring for public authorities. The fine is a mere transfer between the (risk neutral) criminal and the government, and thus it does not appear in the social welfare function (it is not worth from a social point of view).

It is obvious (see also Malik [1990]) that for small values of the external cost of crime and/or large values of the public cost of monitoring, the solution of this problem may be zero deterrence; and under the opposite conditions (large values of the external cost of crime and/or small values of the public cost of monitoring), we may obtain complete deterrence. Thus, we focus rather on the more powerful case with conditional deterrence hereafter.

If an interior solution (p, f) exists, consistent with $\beta'(0) < \frac{1-p}{p^2.F}$, it satisfies the first order conditions of maximization which are written:

$$\frac{1}{B}(D - pf)\frac{\bar{b}}{p(1-p)} = m' + \frac{1}{B}\int_{b^*}^{B}(1 - \hat{\beta})bdb \quad (4)$$

$$\frac{1}{B}(D - pf)\frac{\bar{b}}{f} = \lambda \quad (5)$$

with $\lambda = 0$ if $f < F$ but $\lambda > 0$ otherwise, and denoting $\hat{\beta} = \beta(\hat{x})$. More specifically, the LHS in (4) is the social marginal benefit from the control of illegal activities, while the RHS corresponds to the social marginal cost of controling which takes into account the enforcer's marginal cost of monitoring (first term) and the criminals' marginal cost of dissembling effort (last term). Similarly, the LHS in (5) is the social marginal benefit of fines, and the RHS is their social maginal cost (which is simply the shadow price of the constraint, since fines are costless). Checking for the second order condition (see in the appendix), it is straightforward to verify that it is satisfied as long as $m(p)$ is enough concave,

[7] Since Stigler [1970], the introduction of illegal gains in the social value function is a controversial issue. Both the signifiance and the objective of the penal code are still in debate among scholars; see Dau-Schmidt [1990] and Lewin and Trumbull [1990]; and also more recently Dari-Mattiacci and Garoupa [2007], Fleurbaey, Tungodden and Chang [2003] and Kaplow and Shavell [2001].

[8] This is the most natural specification when we consider that the cost of avoidance corresponds to the disutility of criminals' efforts, and F corresponds to the seizable (legal) earnings or wealth of criminals.

which is a standard assumption in the literature (see for example GAROUPA [2001]).

Consider now a case where the solution in (p, f) is consistent with the condition $\beta'(0) \geq \frac{1-p}{p^2.F}$. The government has now to choose a fine f and a probability of control p in order to maximize the next social welfare function:

$$S = \frac{1}{B}\int_{\bar{b}}^{B} (\pi(x(p,b),p)b - x(p,b) - D)db - m(p) \tag{6}$$

under the constraint $f \leq F$. As compared to (4), note that the first integral term has disapeared (since any criminal who enters also makes an effort) now in (6). If an interior solution (p, f) exists, consistent with $\beta'(0) \geq \frac{1-p}{p^2.F}$, it can be verified that it satisfies the first order condition of maximization:

$$\frac{1}{B}(D - pf)\frac{\bar{b}}{p(1-p)} = m' + \frac{1}{B}\int_{\bar{b}}^{B} (1 - \hat{\beta})bdb \tag{7}$$

together with (5) once more. Note that the unique difference between (4) and (7) comes from the lower bound in the integral term. In (7) $\bar{b}$ is the level of deterrence (corresponding to the separation between non active and active criminals), while in (4) b^* is the threshold allowing the separation between active criminals undertaking or not the effort. This may be understood as follows. Since the LHS in (4) or (7) are identical, the (social) marginal benefit of the deterrence (associated to the separation of the criminals between those who enter and those who do not) is the same for both restrictions on $\beta'(0)$. However all else equal, according to the RHS in (4) and (7), the (social, and specificaly the private) marginal cost of the deterrence is larger under the restriction $\beta'(0) < \frac{1-p}{p^2.F}$ than under $\beta'(0) \geq \frac{1-p}{p^2.F}$. This reflects that in the first case, the effort has a low productivity such that at least some criminals prefer to enter but without making an effort, while others will also invest in the dissembling activity: in this case, the (private) marginal cost of the separation entails an additional separating effect on the population of active criminals. In contrast, in the second case, the effort has a productivity large enough such that any criminal who enters also makes an effort.

This is usefull to understand this since, whether the population separates in two or three, we obtain the following results (the proof is in the appendix):

Proposition 2 *The solution with conditional deterrence (whatever the restriction put on $\beta'(0)$) has the following properties:*

i) The maximum fine $f = F$ is always optimal, and the probability p must be set as small as possible (according to either (4) or (7), depending on the restriction put on $\beta'(0)$).

ii) We obtain that $pF < D$ and there may exist either over or underdeterrence at optimum ($\bar{b} \equiv \frac{p}{1-p}F \gtrless D$).

Result i) is in contrast to the one obtained by MALIK [1990] and LANGLAIS [2008] in the case of detection avoidance *i.e.* when avoidance activities enable criminals to lower the probability of arrestation and punishment: whereas less than maximum fine may be optimal under detection avoidance, this never occurs under dissembling activities. These two different results are easily explained. Under dissembling activities, criminals effort are independent of the fine: raising the fine entails no additional costs on criminals (beyond the expected fine paid in case of arrestation), and thus has only the direct effect on deterrence. Hence, insufficient deterrence obtains unless maximum fines are set. In contrast, with detection avoidance, the fines impose a private cost on criminals, over the expected fine paid in case of arrestation; depending on whether avoidance expenditures become more or less sensitive to the fine, then the enforcement autorities may use less than maximum fine or not.

Part ii) also challenges the usual result of the literature. In the canonical model of Becker, there is not enough deterrence at the optimum: some of the criminals for which the benefit of committing the crime is smaller than the external cost on the society, are not deterred. This is explained by the fact that the level of deterrence corresponds to the expected fine paid by criminals when they are arrested - and random detection is justified by the costly resources used to control criminal activities. In contrast, in the present set up the expected fine is always smaller than the external cost of crime but does not determine the level of deterrence: this latter is set at a threshold high enough to deter only those in the population of criminals who would never engage in dissembling activities; but on the other hand, as far as it is socially worth to deter also some of the active criminals who do make an effort (as soon as their benefit is lower than D), it may be necessary to set the probability of control at a high level given that these individuals are not sensitive to the level of the fine. As a result, the probability may be sometimes set at a level high enough to induce excessive deterrence at optimum. But depending on the properties both of the productivity of the effort and of the technology of dissembling (see the last terms in the RHS of (4) or (7)), the opposite result of underdeterrence may arise, as usually found both by BECKER [1968], as well as MALIK [1990] or SANCHIRICO [2006] under detection avoidance.

Note that it could be possible also that the first best level of crimes occurs (by chance). Nevertheless, in such a case, due to the asymmetric information the penal code always imposes an excessive cost to the society: among the criminals who are not deterred, some do make a dissembling effort although their activity is valuable (*i.e.* they would never be punished if their type were observable), and the distulity cost of their effort reduces the social welfare.

Finally, proposition 2 implies that although maximum fines are always optimal, they have an ambiguous effect on the number of crimes committed when the criminals' type is not observable, and when some of them invest in dissembling activities. In the following, we investigate the consequences of this result more deeply.

4 Countervailing behaviors of repressive policies

4.1 substitutability *vs* complementarity between p and F

As proven by GAROUPA [2001], although the canonical result of Becker is usually understood as establishing the substituability between both instruments, this is not necessarily true. Let us focus here on the degree of substitutability/complementarity between fines and controls, *i.e.* whether the optimal probability decreases or increases with the maximum fine in the presence of dissembling activities[9].

When $\beta'(0) < \frac{1-p}{p^2.F}$, applying the implicit function theorem to (4) with $f = F$, it is easy to verify that $sign\frac{dp}{dF} = signS_{pF}$ with:

$$S_{pF} = \frac{1}{B}\frac{D - 2pF}{(1-p)^2} \tag{8}$$

Similarly, when $\beta'(0) \geq \frac{1-p}{p^2.F}$, applying the implicit function theorem to (7) with $f = F$, it is easy to verify that $sign\frac{dp}{dF} = signS_{pF}$ with now:

$$S_{pF} = \frac{1}{B}\frac{D - (2-p)pF}{(1-p)^2} \tag{9}$$

Hence, given that in both cases we only know that $D > pF$, we may have $S_{pF} < 0$ or $S_{pF} > 0$. Given the ambiguity regarding the sign of S_{pF}, the following result holds, whatever the restriction on $\beta'(0)$:

Proposition 3 *When the maximum fine increases, the optimal probability of control may either decrease or increase.*

This is essentially the same result as the one obtained in the canonical model without avoidance activity; see GAROUPA [2001] for a more detailed discussion of its intuitive meaning: when the maximal fine is high, the level of deterrence is also high (and there may exist overdeterrence); thus, raising F, the enforcer has the opportunity to decrease the probability in order to reduce the enforcements costs. In contrast, when the maximal fine is small (to the limit, close to zero), the level of deterrence is also small, and it may be worth in this case to raise both F and the probability in order to reach enough deterrence.

This first finding has several implications regarding the consequences of more repressive policies on the structure of the population of criminals. We successively analyse the two different restrictions on $\beta'(0)$.

[9] It is worth reminding that F is understood as the maximal criminals' legal earnings.

4.2 case where $\beta'(0) < \frac{1-p}{p^2.F}$

In this case, let us remind that the population is partitioned in three groups (see proposition 1A)). The next proposition and corollaries study the impact of the monetary sanctions (i.e. an increase in the maximal legal earnings) on the distorsion to the first best number of crimes, on the number of criminals undertaking an effort and on the proportion of illegal benefits they can save in case of detection.

Let us begin with:

Proposition 4 *An increase in the maximum fine yields:*

i) an increase in $\bar{b}$ the level of deterrence of crimes when the probability and the fine are complements; this effect is ambiguous when they are substitutes.

ii) a decrease in b^* when the probability and the fine are complements, but to the contrary an increase in b^* when the probability and the fine are substitutes.

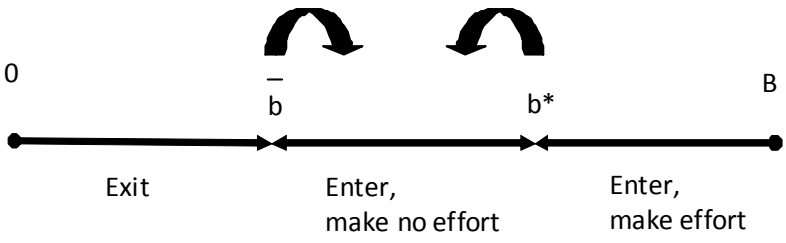
iii) a decrease in $b^* - \bar{b}$ the number of active criminals undertaking no dissembling efforts when the probability and the fine are complements; this effect is ambiguous when they are substitutes.

iv) an increase in $B - b^*$ the number of active criminals making dissembling efforts when the probability and the fine are complements; but to the contrary a decrease in $B - b^*$ when they are substitutes.

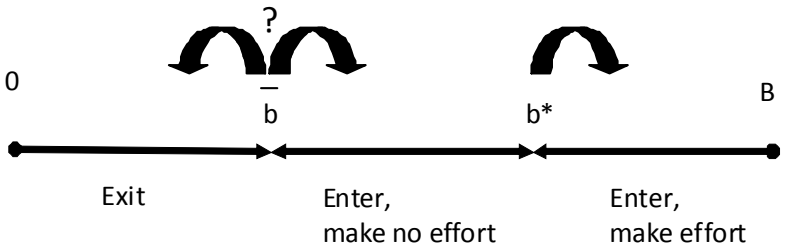
The results are represented in figures 1 A) and B). Part i) may also be worded as: an increase in the maximum fine yields a decrease in $B - \bar{b}$ the total number of criminals if the probability and the fine are complements; otherwise, the effect is ambiguous when they are substitutes.

FIGURE 1
CHANGES IN THE CRIMINAL POPULATION WITH F

A) if p and F are complements



B) if p and F are substitutes



The ambiguity in part i) of proposition 4 is easily explained by the fact that an increase in F has a direct effect on $\bar{b}$ which is always positive, but also an indirect effect through the variation of p which is positive when p and F are supposed to be complementary, but negative when they are substitutable: thus, the total effect depends on whether the first or the second one dominates. The result in ii) reflects that F has only an indirect effect on b^* through the variation of p (which is positive). Obviously, iii) and iv) are directs consequences of i) and ii), and are illustrated in figure 1. An obvious implication of proposition 4 i) is that it is very uncertain whether the enforcement authority has the opportunity to reach a fine tuning of the level of criminality when criminals invest in dissembling activities.

In fact, the following result generally holds. Let us remind that $\bar{b}$ is the level of crime deterrence, and by the standard definition used in the literature there is *overdeterrence* when $D < \bar{b}$ but *underdeterrence* when the opposite inequality holds $D > \bar{b}$:

Corollary 5 *An increase in the maximum fine yields:*

i) a decrease in the level of underdeterrence (if $D > \bar{b}$ holds initially) when the probability and the fine are complements at the optimum;

ii) an increase in the level of overdeterrence (if $D < \bar{b}$ holds initially) when the probability and the fine are complements at the optimum;

iii) otherwise, the effect is ambiguous when the probability and the fine are substitutes.

Notice that the ambiguity arises only when the probability and the fine are substitutes. When the probability and the fine are complements, increasing the sanction has favorable effects in case of underdeterrence, but adverse ones in case of overdeterrence. When underdeterrence occurs at the optimum, then the optimal level of deterrence goes closer to the external cost of crimes as the maximum fine grows up; in other words, the distortion to the first best level

of deterrence is reduced, and public policies become more efficient. On the contrary, when overdeterrence occurs at the optimum, then the distortion with respect to the first best increases as the maximum fine is raised, making the level of deterrence closer to full deterrence.

Finally, it is worth mentioning the impact on the benefits saved by active criminals who make dissembling investments:

Corollary 6 *An increase in the maximum fine implies:*

i) an increase in the benefits saved by any criminal $b > b^*$ when the probability and the fine are complements;

ii) but a decrease in the benefits saved by any criminal $b > b^*$ when the probability and the fine are substitutes.

The result reflects that the proportion $\hat{\beta} = \beta(\hat{x})$ for any $b > b^*$ does not directly depend on F but, through $x(p, b)$, is sensitive to the fequency of controls, with $\frac{d\hat{\beta}}{dF} = \beta'(\hat{x})\frac{\partial \hat{x}}{\partial p}\frac{dp}{dF}$, where $\frac{\partial \hat{x}}{\partial p} > 0$. Thus when the probability and the fine are complements, the increase in F yields a higher level of deterrence (proposition 4i)) but at the same time, more evasion of the illegal benefits (corollary 6i)). In contrast, when the probability and the fine are substitutes, the increase in F has an ambiguous effect on the level of deterrence (proposition 4i)) but yields less evasion of illegal benefits (corollary 6ii))

Remark finally that the case where p and F are complements is of more specific interest, since in this case (proposition 4 i)) $\bar{b}$ becomes closer to b^* as F increases; hence, there exists a value of F for which we are shifted from the case with a three-partitioned population to the second one with a two-partitioned population.

4.3 case where $\beta'(0) \geq \frac{1-p}{p^2.F}$

Now, the population is partitioned in two groups (proposition 1B)) according to the threshold $\bar{b}$. The analysis of such case is easy to perform, using the previous results (and omitting the threshold b^* since it is now irrelevent). It is straightforward to see that an increase in the maximal fine yields:

- (use part i) in proposition 4) an increase in $\bar{b}$ the level of deterrence of crimes (or equivalently a decrease in the number of crimes) when the probability and the fine are complements; this effect is ambiguous when they are substitutes.

- (use corollary 5) a decrease in the level of underdeterrence when the probability and the fine are complements at the optimum, or an increase in the level of overdeterrence when the probability and the fine are complements at the optimum; otherwise, the effect is ambiguous when they are substitutes.

- (use corollary 6) a decrease in the benefits saved by any criminal $b > \bar{b}$ when the probability and the fine are substitutes, and an increase in the benefits saved by any criminal $b > \bar{b}$ when the probability and the fine are complements.

5 Final remarks

This note provides a different view on the effects of the penal code when criminals have the opportunity to undertake avoidance activities. We have modified Malik [1990]'s model to incorporate a continuum of criminals and we assume that those criminals have the opportunity to invest in dissembling activities which allow them to hedge the benefits of the crime when they are arrested and punished (prevent that illegal assets be seized by the enforcer). In this set up, we show that the adoption by criminals of such self-protective measures has major consequences: specifically, we show that maximum fines are always optimal, and that overdeterrence may be optimal. This differs from the results previously obtained by Malik [1990], Langlais [2008], or Sanchirico [2006]: avoidance activities are usually expected to justify the use of less than maximum fines, and to aggravate the problem of underdeterrence which initially appeared in the canonical world *à la* Becker.

More generally, it also challenges the common view which is to condition the design of law enforcement on the seizable wealth of criminals since the maximal possible fine is commonly interpreted as the individual wealth of criminals. For example, Garoupa [2001] concluded that the optimal probability is an inversed U-shaped function in criminals' wealth (both small and large criminals face a low probability of sanction) when wealth is a public information (observable before detection and prosecution). In contrast, when wealth is a private information (Polinsky and Shavell [1991]), the optimal probability is U-shaped with respect to criminal's wealth (both small and large criminals face a large probability of sanction). Our results suggest that in the presence of dissembling expenditures, which are an unavoidable by-product of illegal activities, things are less clear, and more restrictive policies may have counterintuitive and/or adverse effects.

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APPENDIX

A.1: Proof of proposition 1

Define two positive values such as $b^* \equiv \frac{1}{p.\beta'(0)}$ and $\bar{b} \equiv \frac{p}{1-p}.f$, and assume that $\max\left(b^*, \bar{b}\right) < B$; then:

- let us consider a $b < \min\left(b^*, \bar{b}\right)$; by assumption given that $b < b^* \Rightarrow p\beta'(0)b - 1 < 0$, such a criminal makes no dissembling efforts (if he ever enters) otherwise his expected benefit would be decreasing with x; on the other hand since he also satisfies $b < \bar{b} \Rightarrow (1-p)b - pf < 0$, this criminal does not enter otherwise his profit is negative. Thus any criminal having a $b < \min\left(b^*, \bar{b}\right)$ exits (does not commit a crime).

- let us consider now a $b > \max\left(b^*, \bar{b}\right)$; if the individual enters with a $b > b^*$, he undertakes a positive effort $\hat{x} > 0$ satisfying (2) (which is necessary and sufficient to have a unique solution, given the assumptions put on β). On the other hand, given that $b > \bar{b}$ we obtain: $(1-p)b - pf > 0 \Rightarrow u \equiv [(1-p)b - pf] + pb\beta(\hat{x}) - \hat{x} > pb\beta(\hat{x}) - \hat{x}$. By the concavity of $\beta(x)$, it also comes that $\beta(\hat{x}) > \beta'(\hat{x}).\hat{x} \Rightarrow pb\beta(\hat{x}) - \hat{x} > \left(pb\beta'(\hat{x}) - 1\right).\hat{x} = 0$ using (2). Thus, $u > 0$. As a result any $b > \max\left(b^*, \bar{b}\right)$ enters and chooses a $\hat{x} > 0$ according to (2).

- finally, assume that $b^* > \bar{b}$: any b for which both $b > \bar{b}$ and $b \leq b^*$ hold at the same time commits the crime but chooses a $\hat{x} = 0$.

Hence proposition 1, since assuming $\beta'(0) < \frac{1-p}{p^2.f} \Rightarrow b^* > \bar{b}$ (hence, the population separates in three) but assuming $\beta'(0) \geq \frac{1-p}{p^2.f} \Rightarrow b^* < \bar{b}$ in which case the threshold b^* is irrelevent (the population separates in two).

A.2: Proof of proposition 2

Assume that $\beta'(0) < \frac{1-p}{p^2.f}$.

i) Let us consider a solution where the optimal fine satisfies $f < F$. According to (5), this implies that $pf = D$ and thus for any positive probability we obtain

$$S_p = -m' - \frac{1}{B}\int_{b^*}^{B}(1-\hat{\beta})bdb < 0 \tag{10}$$

which is a contradiction to the assumption that it is optimal to control. As a result $f = F$ is optimal, and p must be set as low as possible according to the condition (4). It is easy to verify that the second order condition is satisfied as long as m has enough decreasing returns to scale (left to the reader).

Note that the second order condition requires in this case that:

$$\begin{aligned} S_{pp} &= \frac{1}{B}\left(\frac{1}{1-p}\right)^2\left(\frac{2F(D-pF)}{1-p} - F^2\right) - m'' - \frac{1}{B}\left(\frac{(b^*)^2}{p} - \int_{b^*}^{B}\hat{\beta}'.b.\frac{\partial\hat{x}}{\partial p}db\right) \\ &< 0 \end{aligned} \tag{11}$$

and is satisfied soon as m is enough concave (see also Garoupa [2001]).

ii) Finally, given that the RHS of (5) is positive, it must be that $D > pF$. Hence, there may exist either overdeterrence if $\bar{b} \equiv \frac{p}{1-p}F > D$ is obtained, or underdeterrence if $\bar{b} \equiv \frac{p}{1-p}F < D$ occurs.

The same arguments apply when we assume that $\beta'(0) \geq \frac{1-p}{p^2.f}$ (after substituting $\bar{b}$ for b^*; left to the reader).

A.3: Proof of proposition 4

It is straightforward to show that:

$$\frac{d\bar{b}}{dF} = \frac{p}{1-p} - \frac{F}{(1-p)^2}\frac{S_{pF}}{S_{pp}} \tag{12}$$

where $\frac{dp}{dF} = -\frac{S_{pF}}{S_{pp}}$, and we may have $S_{pF} > 0$ (p and F are complements), or $S_{pF} < 0$ (p and F are substitutes).

As a result, $S_{pF} > 0 \Rightarrow \frac{d\bar{b}}{dF} > 0$.

But when $S_{pF} < 0$, the sign of $F.S_{pF} - p(1-p).S_{pp}$ is ambiguous: S_{pp} is negative (by the second order condition) but has several terms either positive or negative (see in (11)). There exist no obvious restrictions to sign $\frac{d\bar{b}}{dF}$ - specifically because it depends mainly on the properties of $m(p)$, $\beta(x)$ and the sensibility of $x(p,b)$ to p.

On the other hand, the impact on $b^* = \frac{1}{p.\beta'(0)}$ is obvious since as p increases (decreases), then b^* always decreases (respectively, increases). Hence the results, which are more easily summarized in graphs 1A) and 1B) in the text.