

Norm Flexibility and Private Initiative

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Abstract: We model an enforcement problem where firms can take a known and lawful action or exert initiative to find a more profitable action that may enhance or reduce welfare. Enforcers can fine-tune sanctions to an extent that depends on the range admitted by the regulator (norm flexibility). Expected sanctions guide firms' choices among unlawful actions (marginal deterrence) and/or stunt their initiative altogether (average deterrence). With benevolent enforcers, it is optimal to choose maximum norm flexibility, exploiting both marginal and average deterrence. With corrupt enforcers, instead, the regulator will prefer more rigid norms that stunt private initiative, relying on average deterrence only.

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1 Introduction

It is generally recognized that in the presence of market failures, such as externalities, government regulation can improve welfare, but that such intervention must trade off these benefits with the implied resource costs (for enforcement and compliance), as well as with the agency problems that it may generate in the form of corruption or other self-serving behavior by bureaucrats. Regulation cannot be very ambitious or penetrating if its enforcement is very expensive or easily generates the incentive to demand and pay bribes to enforcers (see Acemoglu and Verdier, 2000, Banerjee, 1997, Glaser and Shleifer, 2003, and Immordino and Pagano, 2005, among others).

It is less frequently acknowledged that regulation and its enforcement has yet another possible cost: that of stifling costly innovation by the private sector, for instance research and development (R&D) activity or more generally any form of experimentation that may open profit opportunities but entail risks for society. Of course, the basic idea that one cost of regulation is to stifle private initiative is not new either: it dates back at least to the work by Friedrich Hayek (1935, 1940). However, there is no formal analysis of how the optimal design and enforcement of regulation should take into account the benefits and risks posed by innovation due to private initiative.

In this paper we propose such an analysis, by modeling an enforcement problem where firms can take a known and lawful action (“business as usual”) or exert initiative to find a more profitable action (“innovation”). However, a more profitable action has risks for society: it may enhance or reduce social welfare, i.e. it may create an externality. The regulator must then decide how to take into account both the possible benefits for society and the implied risks. The key difference relative to traditional analysis in law and economics is that regulation acts on two different margins: the private decision to innovate or not, and the choice of the optimal action to take if the innovation is successful.

One class of examples arises in connection with R&D activity and scientific uncertainty. For instance, a biotech firm may either produce traditional seeds or research new genetically modified (GM) seeds that promise higher yields but poses unknown risks to public health (causing allergies in consumers or spreading to neighboring plots).

A second class of examples refer to commercial practices that may result in a limitation of competition. For instance, in antitrust law a given practice, such as the tying of a new product to an existing one (e.g. an application software with an operating system) may result in greater consumer welfare (easier use due to integration) but it may also pose risks of market foreclosure depending on the situation: firms can pursue business as usual, abstaining from tying, or innovate and engage in such practices.

Yet another class of cases may occur in financial markets: financial innovation, for instance the introduction of new instruments or markets, may create new profit opportunities for intermediaries as well as new hedging opportunities for investors, but may also create new dangers for uninformed investors who cannot master the information necessary to handle novel instruments or trade on new markets.

In each of these cases, a regulator can try to deal with the social risks of private innovative activity by imposing rules to sanction the actions that turn out to be most harmful to society. The regulator will entrust the choice of penalties to an enforcer, who will be able to fine-tune them to an extent that depends on the penalty range admitted by the regulator. So a key dimension of the law is its flexibility, that is, the latitude of discretion left to enforcers in choosing the actual penalty.

The expected sanctions will then guide both the firms' choice regarding whether or not to embark in innovative activities and, in case of success, how to exploit the innovation. They may stunt private initiative altogether (average deterrence) and/or induce them to choose less socially harmful actions once they have innovated and an externality occurs (marginal deterrence). We show that, if enforcers can be trusted to be completely loyal, a regulator should choose maximum norm flexibility, exploiting both marginal and average deterrence. Moreover, if the social risks (externality) posed by private innovation are sufficiently low, then under some regularity conditions there is a "laissez-faire" region, where the regulator opts for a per-se legality rule, and therefore effectively lets private initiative free to unfold its effects.

With corrupt enforcers, instead, the regulator will opt for rigid norms that stunt private initiative, since leaving discretion to enforcers would only generate opportunities for officers to threaten misreporting private actions so as to extract bribes from citizens. In this case, the regulator will opt for a flat (and maximal) penalty for any illegal action, and at the same time will step up enforcement activity relative to the case with no corruption. Hence, with corruption in our model marginal deterrence disappears and the effectiveness of the law relies on average deterrence only. Private initiative will be accordingly stifled whenever it is expected to be socially damaging. Hence, the model shows that one of the social costs of corruption arises from the forgone flexibility of the legal system, and from the implied brake on innovation in the economy.

2 The Model

We consider a model with a profit-maximizing firm, a benevolent regulator and – for the time being – a trustworthy enforcer. The firm can either choose one among several known and lawful actions, or invest in learning to identify new actions, whose private and social effects are unknown *ex ante*. For instance, a biotech firm may either produce traditional seeds or experiment with a new GM seed that promises higher yields but poses unknown risks to public health.

The regulator may constrain the firm’s operations by legal norms and associated penalties. To maximize social welfare, he must take into account the tradeoff between the social dividend arising from the firm’s innovations (a larger harvest, in the previous example) and the potential social damage stemming from them (a public health hazard). The key issue that we wish to explore is how this trade-off shapes the optimal design of the legal norms and their enforcement.

The firm can choose the *status-quo* action a_0 (planting traditional seeds) with associated profits Π_0 and welfare $W_0 - a_0$ being the most profitable of the legal actions implementable without investment in learning. In this case, the firm does not learn anything about the function $\Pi(a)$ mapping new projects into the corresponding profits, except the range of these profits, that is, the function’s codomain $[\underline{\Pi}, \overline{\Pi}]$. If the firm does not learn about the new actions, it prefers the *status quo* a_0 , since the expected profits from randomly choosing a new action is lower than that associated with the *status quo*: $E[\Pi(a)] < \Pi_0$, where the expectation is computed using a uniform distribution (a flat prior) over $[\underline{\Pi}, \overline{\Pi}]$.¹ This assumption establishes a positive relationship between investment in learning and choice of a new action. For this reason, hereafter we will refer to investment in learning as “initiative”.

If the firm invests in learning (experimenting with the GM seeds), it can discover how to sort the new actions in an ordered set A such that profits are increasing in the elements $a \in A$ according to a continuous and differentiable function $\Pi(a) \in [\underline{\Pi}, \overline{\Pi}]$. The amount of resources I that the firm invests in learning determine its chances of success: for simplicity, the firm’s probability $p(I)$ of learning the function $\Pi(a)$ is assumed to be linear in I , i.e. $p(I) = I$ with $I \in (0, 1]$. The cost of learning is increasing and convex in the firm’s investment, that is, $c' > 0$ and $c'' > 0$, with $c(0) = c'(0) = 0$ and $\lim_{I \rightarrow 1} c(I) = \lim_{I \rightarrow 1} c'(I) = \infty$. If the firm learns the profitability of new projects, it also learns their social consequences, i.e. the welfare level $W(a)$ associated with each of them. The function $W(a)$ is continuous and linear² in a , with codomain $[\underline{W}, \overline{W}]$. Proceeding with our example, the biotech com-

¹Alternatively, we can simply assume that, without successfully learning, the firm is unable to implement any new action $a \in A$.

²Allowing for concavity or convexity in the welfare function does not add any relevant insight while

pany learns not only the profitability of various alternative GM seeds, but also the dangers that they pose to public health.

Depending on the state of the world, the social consequences of new actions are described by a different function. With probability $1 - \alpha$, a good state materializes: new projects improve welfare, according to a linear and increasing function $W(a) = W_+(a)$ such that $W_+(\underline{a}) \geq W_0$ and $W_+(\bar{a}) = \bar{W}$. In this state, there is no conflict between private and social incentives, since $\Pi'(a) > 0$ and $W'_+(a) > 0$. With probability α , instead, a bad state occurs, where new projects have a negative social externality: welfare is described by a linear and decreasing function $W(a) = W_-(a)$ such that $W_-(\underline{a}) \leq W_0$ and $W_-(\bar{a}) = \underline{W}$. In this case, private incentives conflict with social welfare since $\Pi'(a) > 0$ but $W'_-(a) < 0$. Nature chooses which state of the world occurs; hence, the probability α of the bad state (externality) is an *ex-ante* measure of the misalignment between public interest and firms' objectives.³ In our example, α is the prior probability that the GM seeds will be hazardous to public health.

The norm written by the regulator specifies how to distinguish between legal and illegal actions, and how the latter are punished. Thereby it determines the scope of enforcement activity. Norms can differ by their degree of flexibility, that is, by the extent to which the enforcer can calibrate penalties based on the consequences of the firms' actions. We consider a norm written as follows:

The action $a \in A$ is illegal if ex-post socially damaging, i.e. if $W(a) \leq W_0$. Illegal actions are sanctioned according to a fine schedule $F(W)$ chosen by the enforcement authority in the interval $[\underline{F}, \bar{F}]$ obeying a principle of proportionality, i.e. fines are non-decreasing in social harm $W_0 - W(a)$.

Therefore, norms have three features. First, they are effect-based, that is, they punish only actions that are *ex-post* socially damaging and in proportion to the social harm they cause. Second, the regulator sets the boundaries of enforcement activity, while delegating the precise design of the fine schedule to the enforcement authority. These boundaries consist of the minimum fine \underline{F} and a general principle of proportionality.⁴ At this stage, we rule out agency problems within the government, so that the enforcement authority is

making computations more cumbersome. Hence, we assume a linear relation between the actions and the welfare.

³A more complex settings can be imagined, in which an externality arises only over a subset of the new actions in A , so that even in the bad state not all the projects are socially harmful. This extension would complicate the analysis without adding any substantive result.

⁴The maximum fine \bar{F} is trivially set at the maximum feasible level determined by limited wealth or limited liability, since in this model the well-known principle by Becker (1968) applies.

loyal to the regulator’s mandate – an assumption to be relaxed later on. Third, the higher the minimum fine \underline{F} , the lower the flexibility that the regulator leaves to the enforcement authority in setting fines. Hence, the degree of flexibility is defined by the range of fines $[\underline{F}, \overline{F}]$ available to the enforcer.

Since enforcement is costly, besides designing the law the regulator must decide the amount of resources E to be devoted to its enforcement, for instance the budgetary resources to be allocated to the environmental or health protection agency. These resources determine the probability $q(E)$ that the enforcer correctly identifies the action chosen by the firm and learns its social consequences $W(a)$, and therefore its lawfulness. For simplicity, we assume the probability $q(E)$ to be linear in E , i.e. $q(E) = E$. The cost of the enforcement effort is convex, implying decreasing returns to enforcement: $g' > 0$ and $g'' > 0$ for $E \in (0, 1]$, with $g(0) = g'(0) = 0$ and $\lim_{E \rightarrow 1} g(1) = \lim_{E \rightarrow 1} g'(1) = \infty$. With probability $1 - q(E)$, the authority’s investigation does not unearth enough evidence to inflict any fine on the firm.

The timing of the model is described in Figure 1. At time 1, the regulator writes the norm, including the minimum fine \underline{F} and chooses the resources E devoted to enforcement. At time 2, the enforcement authority commits to the fine schedule $F(W) \in [\underline{F}, \overline{F}]$. At time 3, the firm chooses the initiative I and learns the payoffs of the new projects with probability $p(I) = I$, knowing the norm, the fine schedule and the enforcement level. At time 4, the firm chooses an action, conditional on what it learnt in the previous stage. Finally, at time 5 projects produce their private payoffs Π and their social consequences W ; the enforcement authority collects evidence with probability $q(E) = E$ and possibly levies fines.

[Insert Figure 1]

Regulation precommits the regulator and the enforcer: norm flexibility, enforcement and fine schedule cannot be altered in subsequent stages of the game. This assumption will be partly relaxed in Section 4, where the enforcement authority may fail to implement the statutory fines in exchange for a bribe.

The firm may comply with the law under all circumstances, or it may break the law if the implied profits are sufficiently high. We focus on the latter case, which captures the realistic feature that the law often appears to have incomplete deterrence. Therefore, the maximum payoff from initiative exceeds the maximum fine even when this is inflicted with certainty:

$$\overline{\Pi} - \Pi_0 > \overline{F}. \tag{1}$$

This may capture for instance limited liability of the firms’ owners, which constrains the maximum fine to low levels compared to the profitability of new actions.

3 Benevolent enforcers

We now proceed to develop the equilibrium analysis of the game in the benchmark case where enforcers are benevolent, i.e. maximize social welfare. We solve the game backwards, starting from the last stage, in which the firm chooses its action.

3.1 Firm's actions

The choice of actions at stage 4 depends on whether the firm's initiative was successful or not, and on the fine schedule $F(W)$ designed by the enforcer. If the initiative was unsuccessful, under our assumptions the firm prefers the *status-quo* action a_0 rather than a random new action. If the initiative was successful and there is no externality, all the actions $a \in A$ are lawful, so that the firm chooses the profit-maximising action \bar{a} , which also gives the maximum welfare \bar{W} . If instead the action produces a negative externality, and therefore is unlawful, under the incomplete deterrence assumption (1) the firm chooses the unlawful action that maximizes its profits, net of the expected fine.

In order to gain insight about the optimal choice of a , we need to characterize the fine schedule $F(W)$ chosen at stage 2 by the enforcer. The only restriction that the regulator's stage-1 choice imposes on the shape of this function is the proportionality principle. Then, the enforcer will set the maximum fine \bar{F} at least for the worst action \bar{a} , that will give net profits $\Pi(\bar{a}) - E\bar{F}$. This pins down the best implementable action \hat{a} , such that the firm is indifferent between choosing \hat{a} and pay the minimum fine or choosing \bar{a} and pay the maximum fine:

$$\Pi(\hat{a}) - E\underline{F} = \Pi(\bar{a}) - E\bar{F}. \quad (2)$$

Next, we need to characterize the fine schedule between these two extremes. This is indeterminate, since the proportionality requirement is satisfied by an infinite set of fine schedules. But this indeterminacy is irrelevant, since any schedule satisfying the proportionality requirement is equivalent to the linear stepwise function

$$F(W(a)) = F(a) = \begin{cases} \underline{F} & \text{if } a \leq \hat{a} \\ \bar{F} & \text{if } a > \hat{a} \end{cases} \quad (3)$$

This fine schedule induces the firm to prefer the action \hat{a} to any other action $a > \hat{a}$. The highest profits that the firm could earn by choosing an action $a > \hat{a}$ and incurring the high fine \bar{F} are $\Pi(\bar{a}) - E\bar{F}$. Hence, the firm will be indifferent between the action \hat{a} and the action \bar{a} . This is illustrated by Figure 2: the fine schedule (3) shifts the profit function $\Pi(a)$ downward by \underline{F} to the left of the point \hat{a} , and by \bar{F} to its right. Assuming that, when indifferent, the firm chooses the action less harmful for society, the fine schedule (3) will induce it to choose \hat{a} . Clearly, this is the lowest action that can be induced by any

non-decreasing fine schedule with codomain $[\underline{F}, \overline{F}]$: any action lower than \hat{a} yields lower profits, which cannot be compensated by lowering the penalty below \underline{F} since this is already the minimum penalty.

[Insert Figure 2]

The figure also illustrates that the fine schedule (3) is not the only one, among the non-decreasing schedules with codomain $[\underline{F}, \overline{F}]$, that can induce the action \hat{a} : any such function that penalizes action \hat{a} with \underline{F} and action \bar{a} with \overline{F} will induce the same choice. For example, punishing actions below \hat{a} with \underline{F} and above it with a penalty that makes profits constant achieves the same result. We can summarize the above discussion in the following Lemma.

Lemma 1 *At stage 4 the firm chooses the following actions:*

- a_0 if learning is unsuccessful;
- \bar{a} if learning is successful and there is no externality;
- $\hat{a}(E, \underline{F}) = \bar{a} - \Pi^{-1}[E(\overline{F} - \underline{F})]$ if learning is successful and there is an externality.

Moreover

$$\frac{\partial \hat{a}}{\partial E} = -\Pi^{-1'}(\overline{F} - \underline{F}) < 0 \quad (4)$$

and

$$\frac{\partial \hat{a}}{\partial \underline{F}} = \Pi^{-1'}(E) > 0. \quad (5)$$

When there is an externality and initiative is successful, the regulator tries to guide the firm's choice towards the least damaging illegal action. A higher enforcement effort E and/or a wider range of fines $\overline{F} - \underline{F}$ allows to implement a less damaging action \hat{a} . Both policy tools – enforcement and latitude of the possible sanctions – increase *marginal deterrence*, that is, the regulator's ability to affect the firm's choice of the specific illegal action \hat{a} . In our example, the environmental agency induces firms to opt for GM seeds that are not the most hazardous for society.

3.2 Firm's initiative

At stage 3 the firm chooses its initiative I so as to maximize its expected profits, given the optimal actions that it will choose at stage 4. In terms of our example, the biotech firm chooses how much to invest in R&D on GM seeds, discounting which seeds it will decide to

produce and market upon its R&D effort being successful. Its expected profits at this stage are:

$$E\Pi = \Pi_0 + I \{ \alpha [\Pi(\hat{a}) - E\underline{F}] + (1 - \alpha)\Pi(\bar{a}) - \Pi_0 \} - c(I), \quad (6)$$

where the first term is the *status-quo* profit, the second term is the expected gain from initiative (net of the possible fines) and the third term is the cost of initiative.⁵ By exploiting equation (2), we can rewrite expected profits (6) as:

$$E\Pi = \Pi_0 + I[\bar{\Pi} - \Pi_0 - \alpha E\bar{F}] - c(I). \quad (7)$$

This expression shows that the minimum fine \underline{F} does not affect expected profits (although it does affect the illegal action \hat{a} chosen in the bad state): any increase in \underline{F} is accompanied by an offsetting increase in the implementable action \hat{a} so as to leave net profits equal to the “outside option” $\Pi(\bar{a}) - E\bar{F}$. This is because the enforcement authority always tries to achieve the least damaging action given the indifference condition (2). The first-order condition

$$[\bar{\Pi} - \Pi_0 - \alpha E\bar{F}] - c'(\hat{I}) = 0, \quad (8)$$

yields the following Lemma.⁶

Lemma 2 *The optimal level of initiative*

$$\hat{I} = c'^{-1}(\bar{\Pi} - \Pi_0 - \alpha E\bar{F}).$$

is a decreasing function of enforcement activity and of the probability of the good state:

$$\frac{\partial \hat{I}}{\partial E} = -\frac{\alpha \bar{F}}{c''} < 0, \quad \frac{\partial \hat{I}}{\partial \alpha} = -\frac{E\bar{F}}{c''} < 0.$$

Proof. The results follow immediately from equation (8). ■

The optimal initiative $\hat{I}(E)$ is a continuous and decreasing function of enforcement activity: since the initiative level \hat{I} depends on enforcement, the latter can reduce the probability $p(\hat{I}) = \hat{I}$ that *any* of the new actions $a \in A$ is undertaken, *whether lawful or not*. This result underscores that in our model enforcement has an *average deterrence* effect on private choices, besides the marginal deterrence examined above. This is reminiscent of a result in contract theory proved by Aghion and Tirole (1997): the effort of the principal is a strategic substitute for that of the agent, if both efforts can concur to the solution of a

⁵The second term is always positive, by equation (1): incomplete deterrence implies that the firm always gains from initiative.

⁶The second-order condition for a maximum is fulfilled, by the convexity of $c(I)$.

decision problem. Likewise, in our case, the enforcement effort of the policy-maker depresses the initiative of the firm. The important difference is that in our model the principal's effort cannot directly substitute for the firm's initiative: the regulator can depress the biotech's investment in R&D or affect the type of seeds that it will actually market if successful, but cannot itself undertake R&D.

The optimal initiative \hat{I} is also decreasing in the likelihood of social harm α . When the externality occurs more frequently, the action taken by the firm is more often illegal, leading to more frequent fines that reduce expected profits and discourage initiative. An increase in α increases also the slope of the best reply function $\hat{I}(E)$, as can be seen from the derivative $\frac{\partial \hat{I}}{\partial E}$. Intuitively, an increase in enforcement leads more often to inflicting a fine if α increases (as the action chosen by the firm is more often illegal), and therefore it prompts a greater reduction in initiative.

We assume that, when the firm chooses this optimal initiative level and there is no externality, the increase in social welfare due to private initiative for society, $\bar{W} - W_0$, exceeds its marginal cost to the firm, $c'(\hat{I})$, so that private initiative is socially beneficial:

$$\bar{W} - W_0 - c'(\hat{I}) > 0. \quad (9)$$

Absent this assumption, the regulator would never care about private initiative.

3.3 Enforcement

Having derived the optimal fine schedule $F(W)$ chosen by the enforcer at stage 2, we turn to the choice of enforcement resources E by the regulator at stage 1 – in our example, the resources allocated to the environmental or health protection agency. Expected welfare, taking into account the firm's optimal choice, is:

$$EW = W_0 + \hat{I}(E)[\alpha W_-(\hat{a}(E, \underline{F})) + (1 - \alpha)\bar{W} - W_0] - [g(E) + c(\hat{I}(E))],$$

where the first term is the *status-quo* level of welfare, the second term $\Delta E(\widehat{W}) \equiv \alpha W_-(\hat{a}) + (1 - \alpha)\bar{W} - W_0$ is the expected welfare gain (or loss) stemming from initiative, and the last term captures the public and private costs of initiative. The optimal enforcement is given by the regulator's first-order condition:⁷

$$\frac{\partial EW}{\partial E} = \underbrace{[\Delta E(\widehat{W}) - c'(\hat{I})] \frac{\partial \hat{I}(E)}{\partial E}}_{\text{average deterrence (+/-)}} + \underbrace{\hat{I} \alpha W'_- \frac{\partial \hat{a}}{\partial E}}_{\text{marginal deterrence (+)}} - g' = 0, \quad (10)$$

⁷The second-order condition for a maximum is satisfied:

$$\frac{\partial^2 EW}{\partial E^2} = -c'' \left(\frac{\partial \hat{I}}{\partial E} \right)^2 + \alpha W'_- \frac{\partial \hat{a}}{\partial E} \frac{\partial \hat{I}}{\partial E} - g'' < 0,$$

since $W' < 0$ when the externality arises.

This derivative has a nice interpretation. The first term captures the *average deterrence* of enforcement – the extent to which E discourages initiative, reducing the probability of any new action, whether legal or not. This effect can be positive or negative, depending on whether private initiative has a positive or negative marginal social value $\Delta E(\widehat{W}) - c'(\widehat{I})$.⁸

The second effect, instead, captures the *marginal deterrence* of enforcement – the extent to which enforcement affects the specific choice of actions when the latter generate negative externalities (which occurs with ex-ante probability $\widehat{I}\alpha$). In contrast with average deterrence, the effect of marginal deterrence is always positive, because in the bad state welfare is assumed to be decreasing in the firm's actions ($W'_- < 0$) and the latter are curtailed by enforcement activity ($\partial\widehat{a}/\partial E < 0$, as is apparent from equation (4)).

The third and last term of condition (10) is the marginal cost of deterrence. The optimal enforcement level equalizes the sum of average and marginal deterrence with its marginal cost. The impact of marginal and average deterrence for the optimal enforcement in (10) depend on the likelihood of the externality α , insofar as the latter affects the marginal social value of initiative.

Remark 3 *When the marginal social value of initiative is positive, i.e. $\Delta E(\widehat{W}) - c' > 0$, average deterrence calls for lower enforcement while marginal deterrence calls for more enforcement. When the marginal social value of initiative is negative, i.e. $\Delta E(\widehat{W}) - c' < 0$, both average and marginal deterrence require higher enforcement.*

When private initiative is socially valuable, the enforcer faces a dilemma: lower enforcement would foster valuable private initiative, but at the same time risks allowing more harmful illegal actions, should an externality actually occur. This trade-off is reminiscent of the Hayekian idea that when private initiative is expected to be welfare-enhancing we would like to moderate public intervention so as to preserve private incentives. When, instead, private initiative is ex-ante socially damaging, the dilemma vanishes: average and marginal deterrence work in the same direction, unambiguously requiring higher enforcement.

Equation (10) can also be used to explore how optimal enforcement E^* changes as α increases, that is, as the negative externality becomes more likely. Let us define the following values of α :

$$\alpha_0 : \Delta E(\widehat{W}) - c'(\widehat{I}) = 0$$

⁸If $\alpha = 0$, then $\Delta E(\widehat{W}) - c'(\widehat{I}) = \overline{W} - W_0 - c'(\widehat{I}) > 0$, which is positive by (9). If instead $\alpha = 1$, then $\Delta E(\widehat{W}) - c'(\widehat{I}) = W_-(\widehat{a}) - W_0 - c'(\widehat{I}) < 0$, because in the presence of the externality even the best possible action reduces welfare below the *status quo*: $W_-(\underline{a}) \leq W_0$, by assumption.

and

$$\hat{\alpha} : -[\Delta E(\widehat{W}) - c'(\widehat{I})] \frac{\partial \widehat{I}(E)}{\partial E} = \widehat{I} \widehat{\alpha} W' \frac{\partial \widehat{\alpha}}{\partial E}$$

Notice that $\Delta E(\widehat{W}) - c'(\widehat{I}) > 0$ at $\alpha = \widehat{\alpha}$. We describe in the following Lemma, the optimal enforcement for a subset of values of the likelihood of the externality, α .

Lemma 4 *The optimal enforcement level E^* is zero if $\alpha = 0$ or $\alpha = \widehat{\alpha}$, and is positive if $\alpha = \alpha_0$ or $\alpha = 1$. If $\frac{\partial^2 EW}{\partial E \partial \alpha} > 0$ for any α , then the optimal enforcement level E^* is zero for $\alpha \in [0, \widehat{\alpha}]$ and positive and increasing for $\alpha \in (\widehat{\alpha}, 1]$.*

Proof. When $\alpha = 0$ the first term is negative, given (9), the second is zero and the third is negative. Hence, we have a corner solution at $E^* = 0$. At $\alpha = \widehat{\alpha}$ the first two terms cancel out and, since $g'(0) = 0$, the interior solution requires $E^* = 0$. When $\alpha = \alpha_0$ the first term is zero, the second is positive and therefore the third must be negative and $E^* > 0$ at an interior solution. When $\alpha = 1$, then both the first and the second terms of (10) are positive, and the third must therefore be negative. Hence, $\partial EW / \partial E = 0$ implies an interior solution with $E^* > 0$. Finally, since

$$\frac{dE^*}{d\alpha} = - \frac{\frac{\partial^2 EW}{\partial E \partial \alpha}}{\frac{\partial^2 EW}{\partial E^2}}$$

and $\frac{\partial^2 EW}{\partial E^2} < 0$ due to the second-order conditions, $\text{sign} \frac{dE^*}{d\alpha} = \text{sign} \frac{\partial^2 EW}{\partial E \partial \alpha}$. Then, if $\frac{\partial^2 EW}{\partial E \partial \alpha} > 0$ as assumed in the statement, E^* is obtained from an interior solution. Hence, when $\alpha \in [\widehat{\alpha}, 1]$, is increasing in α . ■

The level of enforcement is positive when the externality is very likely and zero when it is not. Moreover, when the marginal welfare benefit of enforcement increases in α we obtain an increasing level of enforcement when the externality becomes more likely. Although this seems quite intuitive, we cannot prove that a monotone relation between the likelihood of the externality α and the optimal enforcement E^* exists without putting some more restrictions as in the Lemma is done. In the Appendix we discuss in details the possible sources of this non monotonicity. We continue our discussion focussing on the normal case when $\frac{dE^*}{d\alpha} > 0$ for $\alpha \in [\widehat{\alpha}, 1]$.

3.4 Design of norms and fines

Now we turn to the design of the optimal norm and fine schedule. In the discussion below we maintain that $\frac{\partial^2 E(W)}{\partial E \partial \alpha} > 0$ for $\alpha \in [0, 1]$, implying that a positive and increasing enforcement E^* is chosen only when $\alpha > \widehat{\alpha}$. First of all, when the externality is very unlikely, i.e.

$\alpha \in [0, \hat{\alpha}]$, even if the norm would define as illegal those actions in A that reduce social welfare, it would be optimal not to enforce such a prohibition: $E^* = 0$. Anticipating that, the norm would prescribe that all the actions in A are legal (“laissez faire” or “per-se legality rule”).

It is interesting to compare this result with a setting where firms could implement the actions in A without any investment in learning, i.e. when the initiative I is not needed, as traditionally assumed in the literature on law and economics. Such a firm would choose the same actions that, according to Lemma 1, a firm chooses under successful learning: it would choose \hat{a} when an externality arises and \bar{a} otherwise. In this setting, social welfare would be:

$$EW = [\alpha W_-(\hat{a}(E, F)) + (1 - \alpha)\bar{W}] - g(E),$$

and therefore optimal enforcement would be given by:

$$\frac{\partial EW}{\partial E} = \underbrace{\alpha W'_- \frac{\partial \hat{a}}{\partial E}}_{\text{marginal deterrence (+)}} - g' = 0.$$

Clearly, in this case regulation affects private incentives only through marginal deterrence, and enforcement is always positive if an externality may arise: since $g'(0) = 0$, it is evident that $E^* > 0$ for $\alpha \in (0, 1]$. The following Lemma states the different scope of “per-se legality rules” in the two cases.

Lemma 5 *If initiative is not required to take new actions, then laissez faire is adopted only if no externality may occur ($\alpha = 0$). If initiative is required and $\frac{\partial^2 E(W)}{\partial E \partial \alpha} > 0$ for any α , then laissez-faire is selected when the externality occurs with probability $\alpha \in [0, \hat{\alpha}]$.*

This comparison helps understanding the role of initiative in shaping the public intervention: when private investment in learning and innovation is an important piece of the picture, the optimal design of norms requires to limit the intervention by choosing a “per-se legality rule” in a wider set of circumstances ($\alpha \in [0, \hat{\alpha}]$). It is optimal to sacrifice marginal deterrence to preserve high initiative when its marginal social value is sufficiently high.

When instead $\alpha \in (\hat{\alpha}, 1]$, a norm stating that actions in A are illegal if they reduce social welfare, as in our model, are to be optimally enforced, i.e. $E^* > 0$. Hence, the regulator would choose to write the norm as specified in the model. Moreover, the regulator has to choose the range of fines available to the enforcer – that is, norm flexibility. The following proposition summarizes the optimal design of norms.

Proposition 6 *If $\alpha \in [0, \hat{\alpha}]$ and $\frac{\partial^2 EW}{\partial E \partial \alpha} > 0$ for any α , then the regulator chooses a laissez-faire regime. If the externality is more likely ($\alpha \in (\hat{\alpha}, 1]$) the regulator forbids ex-post welfare-reducing actions, and designs the fine schedule with the maximum possible flexibility, that is, sets \underline{F} at the lowest admissible level.*

Proof. The first part is a restatement of the previous lemma. To show the second part, note that if the maximum fine is constrained to some value \bar{F} , for instance due to limited liability, the range of fines is determined by the minimum fine \underline{F} . Since the less damaging illegal action that can be implemented is \hat{a} and

$$\frac{\partial \hat{a}}{\partial (\bar{F} - \underline{F})} = -\Pi'^{-1} E < 0,$$

the larger the range of fines, the lower the action taken by the firm, implying a lower welfare loss. Hence, it is optimal to set the minimum fine \underline{F} at the lowest admissible level (for instance, equal to 0 if no reward is admitted). This choice enhances marginal deterrence while leaving average deterrence unaffected. ■

In our setting, when the externality is sufficiently likely ($\alpha \in (\hat{\alpha}, 1]$) the regulator will always choose to maximize norms' flexibility setting the minimum fine at the lowest feasible level, because choosing a wider range of fines allows to better calibrate penalties on the basis of their welfare effects, achieving greater marginal deterrence. On the other hand, choosing a low punishment \underline{F} for illegal actions up to \hat{a} does not reduce average deterrence: the minimum fine \underline{F} and the (implemented) illegal action \hat{a} , in fact, are adjusted so that the expected profits if initiative is successful are always at the same level, equal to the “outside option” $\bar{\Pi} - E\bar{F}$. Hence, a lower minimum fine \underline{F} comes together with a lower (less profitable) illegal action \hat{a} , without increasing the incentives to exert initiative, i.e. without reducing average deterrence. Summing up, more flexibility enhances marginal deterrence without reducing average deterrence, and it is therefore always desirable.⁹

But the result that norm flexibility is always desirable is no longer true when enforcers are corrupt, as shown in the next section.

4 Corrupt Enforcers

In this section, we abandon the assumption of benevolent enforcers and consider an additional element in the design of law, namely the agency problems that may arise in enforcement. In our setting, the officials that work in the enforcement agency have to collect

⁹Of course, maximum flexibility in setting fines is desirable also in a setting where initiative is not necessary to take new actions, as assumed in traditional law enforcement models: as in that setting only marginal deterrence is at work, maximizing the range of fines always enhances marginal deterrence.

evidence on the firms' conduct and consequences, reporting these facts to the judge (or to the top commissioners of the agency) who decide on the penalty. We assumed so far that the officials correctly report the evidence, as long as they obtain it. However, in their activity these officials are in the position to extract rents from firms: by misreporting their true actions, they can cause the firm to pay a fine different from that inflicted in case of truth-telling. In this section we explore how the design and enforcement of norms is affected when enforcement officials are not committed to truthful reporting and can cater to their private interests rather than to social welfare.

We maintain most of the setup of the previous model, assuming that the regulator chooses both the enforcement effort E (the resources of the agency) and the range of fines $[\underline{F}, \overline{F}]$, while the enforcement agency sets the fine schedule $F(a) \in [\underline{F}, \overline{F}]$. But in the present setting the officials that handle the inquiry about a firm, collecting evidence and presenting it to the judge or the commissioners of the agency, are utility-maximizers rather than welfare-maximizers: that is, they are potentially corrupt. More specifically, we assume that they can misreport the specific action $a \in A$ chosen by the firm, but they cannot lie about the state of nature, i.e. if there is an externality or not. In other words, the enforcer can lie on the finer pieces of information but not on the bolder ones. When the new action is welfare-reducing, then, the official will demand a bribe B to report an action associated to lower (\hat{a}) rather than higher (\bar{a}) fines. The bribe B will correspond to a fraction σ of the forgone fines $\overline{F} - \underline{F}$. We assume that $\sigma \in (0, 1)$, a higher σ corresponding to higher corruption. Since collecting a bribe is illegal, we expect that the corrupt official has not full bargaining power ($\sigma < 1$), being constrained by the possibility that the firm refuses excessive requests and reports it to the judge. The rest of the model remains as in the previous section.

As in the previous section, we proceed by solving the game backward, starting from the last stage in which the firm chooses its action.

4.1 Firm's actions

Misreporting by corrupt officials changes the incentives of the firm to choose among the unlawful actions when learning is successful and an externality arises. The following Lemma summarizes the choice in stage 4.

Lemma 7 *If the corrupt official requires a bribe $\underline{F} + B = \sigma \overline{F} + (1 - \sigma) \underline{F} \leq \overline{F}$ to misreport in case of externality, in stage 4 the firm will choose the following actions:*

- a_0 if the learning effort is unsuccessful;
- \bar{a} if the learning effort is successful.

Proof. The case of no learning and that of learning with no externality are trivial. If however the action produces an externality, and therefore is unlawful, the firm will choose the profit-maximizing action \bar{a} : when the official obtains evidence of the actions a , he will threaten to report the action \bar{a} , with the firm getting expected profits $\Pi(a) - E\bar{F}$, unless a bribe $B = \sigma(\bar{F} - \underline{F})$ is paid. In this latter case, the official will report the action $a = \hat{a}$, making the firm paying the fine \underline{F} . Then, the firm will choose the action $a = \bar{a}$ and pay the fine to the state and the bribe to the official, as long as $\underline{F} + B = \sigma\bar{F} + (1 - \sigma)\underline{F} \leq \bar{F}$. Notice that the corrupt official has no reason to adopt a fine schedule different from that of the benchmark model, since it allows to maximize the collection of bribes. ■

Notice that with corruption we lose *marginal deterrence*, i.e. the ability to influence the choice of the specific illegal action through the design of the policy. Marginal deterrence, assigning different fines to different actions, in fact, creates rents from the activity of investigation and reporting. With corrupt officials misreporting destroys the information needed to implement marginal deterrence

4.2 Firm's initiative

The expected profits at stage 3 when the firm chooses its initiative, given the optimal actions chosen at stage 4, are:

$$E\Pi = \Pi_0 + I \{ \alpha [\Pi(\bar{a}) - E(\underline{F} + B)] + (1 - \alpha)\Pi(\bar{a}) - \Pi_0 \} - c(I). \quad (11)$$

We can rewrite expected profits (11) as:

$$E\Pi = \Pi_0 + I[\bar{\Pi} - \Pi_0 - \alpha E(\sigma\bar{F} + (1 - \sigma)\underline{F})] - c(I). \quad (12)$$

Notice that with corrupt officials the expected profits from initiative depend now, contrary to the benchmark model, on the minimum fine \underline{F} : since the rents from misreporting $\bar{F} - \underline{F}$ depend on the minimum fine, and the firm retains a fraction $(1 - \sigma)$ of them, the expected profits now depend on \underline{F} . Put another way, in the benchmark model the effect of a change in \underline{F} was exactly counterbalanced by an adjustment in the action \hat{a} implemented through marginal deterrence, leaving the net profits unchanged at the level of the “outside option” $\bar{\Pi} - E\bar{F}$. With corrupt officials, instead, marginal deterrence is lost and a change in \underline{F} directly affects the net profits while leaving unchanged the action \bar{a} chosen and the gross profits of the firm.

The optimal initiative \hat{I}^c , where the superscript c refers to corruption, is described in the following lemma.

Lemma 8 *The optimal level of initiative is given by*

$$\widehat{I}^c = c'^{-1}[\overline{\Pi} - \Pi_0 - \alpha E(\sigma \overline{F} + (1 - \sigma) \underline{F})].$$

Moreover,

$$\frac{\partial \widehat{I}^c}{\partial E} = -\frac{\alpha(\sigma \overline{F} + (1 - \sigma) \underline{F})}{c''} < 0, \quad \frac{\partial \widehat{I}^c}{\partial \underline{F}} = -\frac{E\alpha(1 - \sigma)}{c''} < 0 \quad \text{and} \quad \frac{\partial \widehat{I}^c}{\partial \sigma} = -\frac{E\alpha(\overline{F} - \underline{F})}{c''} < 0.$$

Finally, $\widehat{I}^c > \widehat{I}$ and $\frac{\partial \widehat{I}^c}{\partial E} > \frac{\partial \widehat{I}}{\partial E}$ for any $\sigma \in (0, 1)$ and $\widehat{I}^c \rightarrow \widehat{I}$ when $\sigma \rightarrow 1$.

Proof. All these results can be easily derived from the FOC. ■

The second and third comparative statics results are new with respect to the benchmark model with benevolent enforcers. Increasing the minimum fine reduces \widehat{I}^c because it increases the overall payment of the firm to the state and to the corrupt official, discouraging initiative. A similar effect comes from an increase in the level of corruption (σ), that implies higher overall payments in case of externality.

If we compare the level of initiative in the benchmark model and in the case of corrupt officials, other things equal, it is easy to see that initiative is higher with (partial) collusion, with the gap vanishing when corruption is very high. As we argued above, with corrupt officials the profits $\Pi(\bar{a}) - \alpha E(\underline{F} + B)$ expected when initiative is successful are higher than those in the benchmark case ($\Pi(\bar{a}) - \alpha E\overline{F}$), due to lower total payments, inducing more initiative ; since total payments increase up to \overline{F} when corruption is higher, initiative in the two regimes converge in the limit as $\sigma \rightarrow 1$.

Similar arguments explain why enforcement effort creates lower disincentives to initiative when there is corruption, i.e. a flatter best reply function. Hence, corruption not only destroys marginal deterrence but makes average deterrence less effective.

4.3 Enforcement

We can now move to the choice of the enforcement effort E in stage 1. The expected welfare, once taken into account the firm's optimal choices, is:

$$EW^c = W_0 + \widehat{I}^c(E)[(1 - \alpha)\overline{W} + \alpha\underline{W} - W_0] - [g(E) + c(\widehat{I}^c(E))].$$

The optimal effort choice is therefore given by:

$$\frac{\partial EW^c}{\partial E} = \underbrace{[\Delta E(\overline{W}) - c']}_{\text{average deterrence (+ / -)}} \frac{\partial \widehat{I}^c(E)}{\partial E} - g' = 0 \quad (13)$$

where $\Delta E(\overline{W}) \equiv [(1 - \alpha)\overline{W} + \alpha\underline{W} - W_0]$ is the expected change in welfare relative to the status quo if the initiative is successful, while the term in square brackets measures the marginal social value of initiative.¹⁰

Looking at (13), the first term captures average deterrence. This effect can be positive or negative, depending on whether initiative has a positive or a negative marginal social value. As noted before, with respect to the benchmark model we do not have anymore the *marginal deterrence* effect. In order to identify the optimal enforcement let us introduce the following term:

$$\alpha_0^c : \Delta E(\overline{W}) - c'(\widehat{I}^c) = 0$$

The following lemma states the optimal enforcement effort as a function of the likelihood of the externality.

Lemma 9 *With corruption, the optimal enforcement level E^{*c} is zero if $\alpha = 0$ or $\alpha = \alpha_0^c$, and is positive at $\alpha = 1$. If $\frac{\partial^2 EW^c}{\partial E \partial \alpha} > 0$ for any α , the optimal enforcement E^{*c} is zero for $\alpha \in [0, \alpha_0^c]$ and positive and increasing for $\alpha \in (\alpha_0^c, 1]$. Moreover α_0^c increases when corruption is larger.*

Proof. Given the definition of α_0^c and $g'(0) = 0$, it follows that $E^{*c}(\alpha_0^c) = 0$. When $\alpha = 0$, given 9, the derivative is negative and we have a corner solution $E^{*c}(0) = 0$. When $\alpha = 1$ the marginal social value of initiative is negative and the first term in (13) is positive, implying an internal solution with $E^{*c} > 0$. We know that $\text{sign} \frac{dE^{*c}}{d\alpha} = \text{sign} \frac{\partial^2 EW^c}{\partial E \partial \alpha}$. When this latter is positive the first term in (13) is initially negative and increases in α . Given the convexity of $g(E)$, this implies initially a corner solution $E^{*c}(\alpha) = 0$ for $\alpha \in [0, \alpha_0^c)$, an internal solution $E^{*c}(\alpha_0^c) = 0$, and positive and increasing values of E^{*c} as α increases further.

Next we want to understand the effect of corruption on optimal enforcement. The sign of $\frac{dE^c}{d\sigma}$ is the same as that of the cross-partial derivative:

$$\frac{\partial^2 EW^c}{\partial E \partial \sigma} = -c'' \frac{\partial \widehat{I}^c}{\partial \sigma} \frac{\partial \widehat{I}^c}{\partial E} + (\Delta E(\overline{W}) - c') \frac{\partial^2 \widehat{I}^c}{\partial E \partial \sigma} = E\alpha (\overline{F} - \underline{F}) \frac{\partial \widehat{I}^c}{\partial E} + (\Delta E(\overline{W}) - c') \frac{\partial^2 \widehat{I}^c}{\partial E \partial \sigma}$$

Since the first term is always negative and the second is zero at $\alpha = \alpha_0^c$, we get $\frac{dE^{*c}}{d\sigma} < 0$ in a right neighborhood of α_0^c . This implies that with more corruption the region of no enforcement becomes larger, i.e. α_0^c is increasing in σ . ■

¹⁰The second derivative is :

$$\frac{\partial^2 EW^c}{\partial E^2} = -c'' \left(\frac{\partial \widehat{I}^c}{\partial E} \right)^2 - g'' < 0.$$

With corrupt officials deterrence works only through its average effect. Then the regulator assigns resources to law enforcement only if initiative has a negative social value. With more corruption initiative is relatively more discouraged and therefore average deterrence is less urgent, *ceteris paribus*. Then we can save enforcement resources by shifting slightly the region of enforcement: the regulator starts supporting enforcement when the externality is slightly more likely.

4.4 Design of norms and fines

We turn now to the stage where the regulator writes the norm and defines the set of fines, maintaining that $\frac{\partial^2 EW^c}{\partial E \partial \alpha} > 0$ for $\alpha \in [0, 1]$. First of all, when the externality is sufficiently unlikely ($\alpha \in [0, \alpha_0^c]$), such that initiative has a positive marginal social value, anticipating that it is optimal not to implement any prohibition, the regulator would opt for a per-se legality rule in which all the actions in A are lawful and no resource E is dedicated to enforcement. Hence, in the model with corrupt officials a per-se legality rule is always adopted if initiative has a positive social value.

If we compare this result with the optimal design of norms in the benchmark model, we can notice that in this latter case the per-se legality regime (*laissez faire*) is abandoned, moving to an effect based norm prohibiting actions that are ex-post socially damaging, when initiative has still a (moderate but) positive marginal social value ($\alpha = \hat{\alpha}$); the same norm is further adopted also when the externality is even more likely. We state this comparison in the following lemma.

Lemma 10 *With corrupt officials the conditions for adopting a per-se legality rule are laxer than with benevolent ones, requiring that the marginal social value of initiative is non negative, and not strictly positive as in the benchmark model.*

However, it should be kept in mind that this does not amount to saying that in general $\hat{\alpha} > \alpha_0$, i.e. that the set of value of the parameter α associated to a per-se legality rule is wider in case of corrupt officials. In fact, although it is easy to verify that, when $\alpha = \alpha_0^c$, we have $0 = \Delta E(\bar{W}) - c'(\hat{I}^c) < \Delta E(\widehat{W}) - c'(\hat{I})$, we do not know in general if this implies that $[\Delta E(\widehat{W}) - c'(\hat{I})] \frac{\partial \hat{I}(E)}{\partial E} = -\hat{I} \alpha W'_- \frac{\partial \hat{\alpha}}{\partial E}$ that implicitly defines $\hat{\alpha}$.

Moving to the optimal design of fines, when the externality is more likely, i.e. $\alpha \in (\alpha_0^c, 1]$, the effect based norm specified in the benchmark model is enforced; the regulator then sets the minimum fine optimally. In this case the optimal minimum fine is determined by the first derivative:

$$\frac{\partial EW^c}{\partial \underline{F}} = \underbrace{[\Delta E(\overline{W}) - c'] \frac{\partial \hat{I}^c(E)}{\partial \underline{F}}}_{\text{average deterrence (+)}} \quad (14)$$

that is positive in the region $\alpha \in (\alpha_0^c, 1]$. Then the following results follows:

Proposition 11 *If $\frac{\partial^2 EW^c}{\partial E \partial \alpha} > 0$ for $\alpha \in [0, 1]$, with corrupt officials when initiative has a non-negative social value ($\alpha \in [0, \alpha_0^c]$) the regulator adopts a per-se legality rule (*laissez faire*). When instead initiative has a negative social value $\alpha \in (\alpha_0^c, 1]$ the regulator opts for an effect based norm and minimizes norm's flexibility by setting $\underline{F} = \overline{F}$.*

Notice that by squeezing the range of fines, i.e. setting $\underline{F} = \overline{F}$, the regulator magnifies the average deterrence effect, since the total payment $B + \underline{F}$ converges to \overline{F} when $\underline{F} = \overline{F}$, reducing the expected profits from initiative. Moreover, when \underline{F} increases, \hat{I}^c and c' decrease while $\frac{\partial \hat{I}^c}{\partial E}$ increases in absolute terms, making the first term in 13) larger, fostering a higher effort E . Hence, minimum fine and enforcement effort are complements rather than substitutes in the model with corrupt officials.

In summary, when officials are corrupted we lose marginal deterrence and the policy itself works only through average deterrence. This is realized both through an increase in the (costly) enforcement effort E and by increasing the minimum fine \underline{F} .

Setting the minimum fine optimally, i.e. $\underline{F} = \overline{F}$, the scope for corruption is eliminated, as the fine reduction $(\overline{F} - \underline{F})$ that the corrupt official can pledge by misreporting vanishes, and the corrupt official is unable to get any bribe from the firm. Although corruption is eliminated, the possibility of misreporting strongly influences the design of the optimal design and enforcement of law. Reducing the discretionality of the corrupt official (by increasing the minimum fine \underline{F}), i.e. making the norm more rigid, in fact, is the only way to improve average deterrence, given that corruption reduces the overall payment $(\underline{F} + B)$ paid by the firm.

In this sense, corruption creates two inefficiencies: it eliminates, as a consequence of misreporting, the ability to influence the firms in their choice of the illegal action (no marginal deterrence); moreover, corruption leaves to the firm a fraction $1 - \sigma$ of the rents from misreporting, softening the overall payments in case of misbehavior and fostering (welfare reducing) initiative. The regulator chooses a rigid norm to counteract this latter effect.

5 Per-se illegality rule

Since with corrupt officials the regulator opts for a rigid effect based norm, restricting the set of fines to \bar{F} , it is interesting to analyze whether a different, and even more rigid, type of norms could be superior. In this section we analyze the case of a per-se illegality rule that prohibits any action $a \in A$ no matter which are the effects on welfare, imposing the maximum fine \bar{F} if any $a \in A$ is reported. Notice that a flat fine schedule eliminates the rents from misreporting on actions $a \in A$ and therefore eliminates corruption. The difference between a per-se illegality rule and the rigid effect based norm of the previous paragraph is evident when a new action ex-post increases welfare: this action is fined according to a per-se illegality rule while it is not under the effect based regime.

Since the model is quite similar to the previous cases treated, we quickly go through the equilibrium analysis. If the learning effort is not successful the firm chooses the status quo action α_0 , while if the firm learns the new actions it chooses \bar{a} . The expected profits when initiative effort is decided are therefore

$$E\Pi = \Pi_0 + I[\bar{\Pi} - \Pi_0 - E\bar{F}] - c(I).$$

and the optimal initiative requires:

$$[\bar{\Pi} - \Pi_0 - E\bar{F}] - c'(\hat{I}^r) = 0$$

where the superscript r stands for per-se illegality rule. We can immediately see that initiative is lower under a per-se illegality rule than under a rule of reason with corrupt officials (and minimum fines optimally set at \bar{F}), because the fine is always paid in the former case and only when the externality occurs in the latter. Also the best reply function

$$\frac{\partial \hat{I}^r}{\partial E} = -\frac{\bar{F}}{c''} < 0,$$

is steeper under a per-se prohibition. Turning to the expected welfare, its expression is now:

$$EW^r = W_0 + \hat{I}^r(E)[(1 - \alpha)\bar{W} + \alpha\underline{W} - W_0] - [g(E) + c(\hat{I}^r(E))]$$

The optimal enforcement therefore requires:

$$\frac{\partial EW^r}{\partial E} = \underbrace{[\Delta E(\bar{W}) - c']}_{\text{average deterrence (+ / -)}} \frac{\partial \hat{I}^r(E)}{\partial E} - g' = 0$$

implying no enforcement ($E^{*r} = 0$) when initiative has a positive marginal social value and positive enforcement otherwise, as in the case of effect based norms with corrupt officials. Let us define

$$\alpha_0^r : \Delta E(\bar{W}) - c'(\hat{I}^r) = 0$$

as the level of α that makes the marginal social value of initiative nil.

The ranking of initiative and enforcement and the threshold level of α in the two cases is stated in the following Lemma.

Lemma 12 *When officials are corrupt, initiative is higher and enforcement is lower under an effect-based norm with corrupt officials than with a per-se illegality rule, i.e. $\hat{I}^c > \hat{I}^r$ and $E^{*c} < E^{*r}$. Moreover $\alpha_0^r > \alpha_0^c$.*

Proof. Since $\hat{I}^c > \hat{I}^r$ from the first order conditions of the two problems, given the convexity of $c(I)$ and $g(E)$ we have $c'(\hat{I}^c) > c'(\hat{I}^r)$ and $\frac{\partial \hat{I}^c}{\partial E} < \frac{\partial \hat{I}^r}{\partial E}$ in absolute value, implying that $g'(E^{*c}) < g'(E^{*r})$ and $E^{*c} < E^{*r}$. The last result immediately follows from the definitions of α_0^r and α_0^c given that $c'(\hat{I}^c) > c'(\hat{I}^r)$. ■

Hence, a per se illegality rule implies a higher average deterrence, i.e. lower private (bad) initiative, and higher enforcement effort with respect to an effect based norm with corrupt officials. Moreover, under the usual regularity conditions the legislator will adopt a per-se illegality rule for $\alpha \geq \alpha_0^r > \alpha_0^c$, i.e when the externality is more likely than in the previous case. Comparing the welfare level in the two cases, we have

$$EW^r - EW^c = \Delta E(\bar{W}) (\hat{I}^r - \hat{I}^c) + [g(E^{*c}) - g(E^{*r})] + [c(\hat{I}^c) - c(\hat{I}^r)]$$

The first term is positive when either of the two policies is enforced ($\Delta E(\bar{W}) < 0$), given that initiative is lower under a per-se prohibition. The second is negative because enforcement and its costs are higher with per-se illegality while the opposite goes through with the last term. Hence, with corrupt officials the choice between an effect based rigid norm and a per-se illegality rule depends on whether the more effective average deterrence is justified by the net saving in costs due to a shift from private initiative to public enforcement.

6 Conclusion

In this paper we have studied the design and enforcement of the norms that apply to the outcomes of an innovative process, highlighting their effects not only on the specific choices of private agents but also on their learning effort. In our setting, in order to innovate firms must take a costly initiative, that is, exert effort to learn about the consequences of innovation. Then, if successful, they can implement the innovation itself. Ex ante, implementing the innovation can enhance or reduce social welfare, that is, produce positive or negative externalities.

Norms have two effects on private incentives: on the one hand, by fine-tuning penalties to the effects of private actions, they can influence the firms' choice among the new actions, limiting social harm whenever these actions create a negative externality. This is the traditional "marginal deterrence" of sanctions. A second and new effect arises in our model because the norm affects, through fines and their enforcement, the expected profits from initiative, thereby reducing or enhancing firms' effort to innovate and the probability that any innovative action will be taken. We label this as "average deterrence".

In this setting we analyze how the norms are designed and enforced. In particular, we consider as the benchmark case an effect-based norm that identifies unlawful actions as those that reduce welfare ex post. Hence, the new actions that firms discover through their initiative are unlawful only if ex post a negative externality occurs. The flexibility of the norms depends on the possibility of assigning different fines to different unlawful actions, i.e. on the range of fines admitted.

When initiative is successful and there is no externality, the firm chooses the most profitable and welfare-enhancing action. When instead the new actions are welfare-reducing (and therefore unlawful), the fine schedule induces them to select a less harmful action than they would have done otherwise (marginal deterrence). Enforcement by the regulator makes marginal deterrence more effective and reduces the expected profits from initiative, reducing therefore innovation by firms (average deterrence). This is desirable if, in expected terms, initiative reduces welfare, i.e. if the externality is relatively likely. But if initiative is ex-ante welfare enhancing, then the effects of enforcement effort via marginal and average deterrence work in opposite directions. Under some parameter restrictions, we obtain a non-decreasing relation between the likelihood of the externality and the optimal enforcement level. So the legislator will choose a laissez-faire regime (a per-se legality rule) if the marginal social value of initiative is positive and sufficiently large, i.e. if the negative externality is unlikely, and an effect-based flexible norm otherwise. Indeed in the latter case by maximizing the range of fines (a flexible norm), the legislator will maximize marginal deterrence without reducing average deterrence.

When we abandon the assumption of a benevolent enforcer, that is consider officials who can misreport the action observed demanding a bribe, marginal deterrence is lost and enforcement works only through average deterrence. In this case, when the marginal social value of initiative is positive the regulator chooses laissez-faire more often than with benevolent enforcers. Instead, when initiative is expected to be socially harmful, the regulator opts for a rigid effect-based norm, minimizing the range of fines admitted. In the extreme, he may go for an even more rigid norm, i.e. a per-se illegality rule.

Bibliography

- Acemoglu, Daron and Thierry Verdier (2000), “The Choice Between Market Failures and Corruption,” *American Economic Review* **90**(1), 194–211.
- Aghion, Philippe, and Jean Tirole (1997), “Formal and Real Authority in Organizations,” *Journal of Political Economy* **105**(1), 1–29.
- Banerjee, Abhijit V. (1997), “A Theory of Misgovernance,” *Quarterly Journal of Economics* **112**(4), 1289–1332.
- Becker, Gary S. (1968), “Crime and Punishment: An Economic Approach,” *Journal of Political Economy*, **76**, 169–217.
- Becker, Gary S. and George J. Stigler (1974), “Law Enforcement, Malfeasance and Compensation of Enforcers,” *Journal of Legal Studies* **17**(1), 65–81.
- Bowles, Roger and Nuno Garoupa (1997), “Casual Police Corruption and the Economics of Crime,” *International Review of Law and Economics* **17**(1), 65–81.
- Glaeser, Edward L. and Andrei Shleifer (2003), “The Rise of the Regulatory State,” *Journal of Economic Literature* **41**(2), 401–25.
- Hart Herbert L. A. (1961), *The Concept of Law*, Oxford, Oxford University Press.
- Hayek Friedrich (1935), *Collectivist Economic Planning: Critical Studies on the Possibilities of Socialism*, London, Routledge.
- Hayek Friedrich (1940), “Socialist Calculation: the Competitive ‘Solution’”, *Economica* **7**, 125–49.
- Kaplow, Louis (1992), “Rules versus Standard: an Economic Analysis,” *Duke Law Journal* **42**, 557–624.
- Immordino, Giovanni and Marco Pagano (2005), “Legal Standards, Enforcement and Corruption,” CSEF Discussion Paper no. 98.
- Laffont, Jean-Jacques and Jean Tirole (1993), *A Theory of Incentives in Procurement and Regulation*, Cambridge, MIT Press.
- Lange, Oskar (1936), “On the Economic Theory of Socialism,” *Review of Economic Studies*, 53–71.
- Mookherjee Dilip and I. Png (1994), “Marginal Deterrence in the Enforcement of Law,” *Journal of Political Economy* **102**, 1039–66.

- Polinsky, A. Mitchell and Steven M. Shavell (2000), “The Economic Theory of Public Enforcement of Law,” *Journal of Economic Literature* **38**(1), 45-76.
- Polinsky, A. Mitchell and Steven M. Shavell (2001), “Corruption and Optimal Law Enforcement”, *Journal of Public Economics* **81**(1), 1-24.
- Posner, Richard A. (1992), *The Economic Analysis of Law*, 4th Edition. Boston: Little Brown.
- Steven Shavell (1993), “The Optimal Structure of Law Enforcement,” *Journal of Law and Economics* **36**(1), Part 2, 255-287.
- Stigler, George J. (1970), “The Optimum Enforcement of Laws,” *Journal of Political Economy*, **78**(3), 526-536.
- Xu, Chenggang and Katharina Pistor (2002), “Law Enforcement under Incomplete Law: Theory and Evidence from Financial Market Regulation,” Columbia Law School Working Paper Series No. 222.

7 Appendix

In this Appendix we show why a non monotone relation between the likelihood of the externality α and the optimal enforcement E^* may occur. We know that $\text{sign} \frac{dE^*}{d\alpha} = \text{sign} \frac{\partial^2 EW}{\partial E \partial \alpha}$. Let us consider this derivative and its components:

$$\begin{aligned} \frac{\partial^2 EW}{\partial E \partial \alpha} &= \frac{\partial(\Delta E(\widehat{W}) - c')}{\partial \alpha} \frac{\partial \widehat{I}}{\partial E} + (\Delta E(\widehat{W}) - c') \frac{\partial^2 \widehat{I}}{\partial E \partial \alpha} + W'_- \frac{\partial \widehat{a}}{\partial E} \frac{\partial(\alpha \widehat{I})}{\partial \alpha} = \\ &= \left[-c'' \frac{\partial \widehat{I}}{\partial \alpha} - (\overline{W} - \widehat{W}) \right] \frac{\partial \widehat{I}}{\partial E} + [\Delta E(\widehat{W}) - c'] \frac{\partial^2 \widehat{I}}{\partial E \partial \alpha} + W'_- \frac{\partial \widehat{a}}{\partial E} \left[\alpha \frac{\partial \widehat{I}}{\partial \alpha} + \widehat{I} \right] \end{aligned}$$

The first term measures how the marginal social value of initiative $\Delta E(\widehat{W}) - c'$ varies when the externality becomes more likely. On the one hand it decreases, since the bad outcome \widehat{W} occurs more often while the good outcome \overline{W} is less likely; on the other hand, since initiative is discouraged when the externality is more likely ($\frac{\partial \widehat{I}}{\partial \alpha} < 0$ when $E > 0$), the costs of initiative decrease, improving the welfare effect. This latter term vanishes when no enforcement is exerted (at $\alpha = \widehat{\alpha}$ and at $\alpha = 0$).

The second term in the cross partial derivative can be interpreted as follows: when α increases, the displacement effect of enforcement on private initiative becomes stronger (the best reply function $\frac{\partial \widehat{I}}{\partial E}$ becomes steeper). The second term measures how this effect impacts on welfare. It will be positive if the marginal social value of initiative is negative, while the opposite goes through if $\Delta E(\widehat{W}) - c' > 0$.

Finally, marginal deterrence works (ex post) only in the bad states when the externality occurs. In this case, an increase in enforcement increases always welfare ($W'_- \frac{\partial \widehat{a}}{\partial E} > 0$). This beneficial effect of enforcement occurs ex-ante with probability $\widehat{I}(\alpha)\alpha$, i.e. when the externality occurs and the firms learn how to commit the illegal action. The third term of the cross partial derivative measures the effect on marginal deterrence of an increase in α , that works directly making the bad state more likely and indirectly, through a decrease in $\widehat{I}(\alpha)$. If this latter is inelastic, i.e. if $\alpha \frac{\partial \widehat{I}}{\partial \alpha} + \widehat{I} > 0$, the direct effect prevails and the ex-ante probability $\alpha \widehat{I}(\alpha)$ that marginal deterrence works through enforcement increases in α .

From this discussion we conclude that without putting some more structure in the model it may be that some non monotonicity occurs in $E^*(\alpha)$.

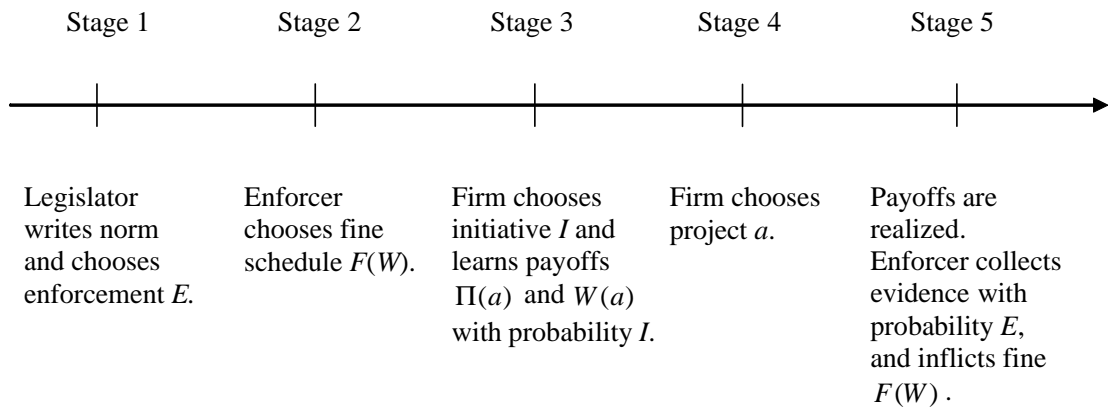


Figure 1: Time line.

