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OPTIMAL LENIENCY PROGRAMS IN ANTITRUST

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WORKING PAPERS

2010/18

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Titolo: OPTIMAL LENIENCY PROGRAMS IN ANTITRUST

ISBN: 978 88 84 67 610 8

Prima Edizione: Agosto 2010

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09123 Cagliari
Tel./Fax 070 291201
www.cuec.it

Optimal Leniency Programs in Antitrust*

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Abstract

This paper analyses the incentive structure underlying the adoption of leniency programs in antitrust enforcement. The enforcement of competition law is treated as the delegation of the economic activity from the government to private firms. The model contributes to the debate over desirability of granting leniency to more than one cartelists. For this purpose, I introduce a probability of conviction that depends on authority-specific characteristics. This results in the optimal number of leniencies being specific to national authorities and market structures. The model confirms a result widely acknowledged in the antitrust literature: a program that merely reduces sanctions to the first reporter is ineffective.

JEL Classification: K21, L13, L14.
Keywords: Antitrust, Leniency, Deterrence.

*I thank David Martimort and Tommaso Valletti for useful comments.

1 Introduction

Firms perform the economic activity in market economies so that the allocation of inputs and products is governed by the price mechanism.

The first fundamental welfare theorem ensures the competitive equilibrium leads to a Pareto efficient allocation, provided some assumptions are satisfied.

In particular, the efficiency of market equilibria no longer holds when players on the one side of the market are able to distort the price mechanism. For this reason, most countries ban collusive practices. If firms form a cartel they can in fact easily impose the market power of their coalition.

By enforcing an antitrust regulation the social planner - hereafter named the legislator - tries and implement competitive markets to lead to attain a level of social welfare higher than in an economy with collusion.

In the present paper I study how leniency programs may affect the enforcement of competition law. To carry this analysis I start by the model of Besanko and Spulber (1989), interpreting the conflict between firms and the antitrust authority as the problem of delegating a task, the economic activity, to agents who own private information about their actions in team.

This situation involves a conflict between different objective functions in a framework with private information. As is well known, asymmetric information generally prevent economies from achieving the first best allocation of resources attainable if the firms pricing conduct was verifiable.[1]

Leniency programs are the tool most countries adopted over the last decades to correct the informative gap between firms and the legislator. Such schemes consist in granting partial or total immunity from the sanctions for anticompetitive behaviour to firms that, although previously involved in the misconduct, contribute to the conviction of their accomplices and conform to the admission conditions fixed by the legislator.

This work analyzes the effects of leniency programs in an infinitely repeated coordination game. In this early version of the paper I focus

[1] Laffont and Martimort (2002).

on two important issues related with the implementation of a leniency program: its effectiveness and the optimal number of firms to benefit from it.

After a brief review of the most relevant literature in section 2, I analyse in section 3 the effect leniency programs have on collusive behaviour. Section 4 contains the innovative results of the paper, in particular on the debate about allowing one or more cartelists to benefit from leniency. Section 5 concludes.

2 Related literature

The proliferation of leniency programs around the world and their claimed effectiveness have driven many economists to investigate how leniency programs affect the behaviour of firms and to what extent their effectiveness can be improved.

The pioneering paper on leniency programs is Motta and Polo (2003). In their model an antitrust authority facing an exogenous budget constraint enforces a veto on cartels given two probabilities of detection and conviction, both increasing with the amount of resources endogenously devoted to each of the two activities.

The paper shows that granting leniency to firms that are already under investigation may be an optimal policy, whenever important evidence against the cartel is missing and the budget constraint is tight. This allows in fact the authority to invest in the activity of detection resources otherwise used to collect evidence on individuated cartels.

Spagnolo (2000) disregards the effect of leniency on enforcement costs and focuses on its deterrent effect. In his model, leniency is an optimal policy when it is granted to the first whistleblower and only before an investigation begins.

A courageous program, that is one granting a reward to the informer, enables the Authority to reach a fully competitive outcome without supporting any cost of enforcement.

Ellis and Wilson (2002) identify on strategic cost advantages a reason that can induce a colluding firm to apply to leniency programs even before the Authority suspects it of anticompetitive behaviour. By applying for leniency, a firm can increase the future average costs of its rival who have to pay the fine.

The model points out a dangerous effect of leniency programs: if a cartel is profitable enough to be set up under the functioning of a leniency program, each cartelist has incentive to ask for leniency in case a partner deviates, so that the fine is added to the usual punishment for defections - i.e. reversion to static Bertrand equilibrium - and the collusive agreement is stabilized.

Nevertheless, Spagnolo (2004) shows that when reduced fines under leniency program are below the expected fine of an agent that deviates from collusion and does not report, moderate leniency programs still deter cartels.

Harrington (2008) considers the dynamic features of colluding firms when they are under investigation. The author identifies three different effects of leniency on cartel deterrence: a cartel-amnesty effect, a race-to-the-courthouse effect and a cartel-defector effect.

The first effect increases the payoff from colluding, whilst the second one fosters competition and induces each firm to denounce its partners in crime as soon as possible, in order to enter the limited number of admitted firms. The last effect is of the same kind as that highlighted by Ellis and Wilson (2002) : it decreases the individual punishment in case of deviation and so thwarts collusion.

3 Economic analysis of leniency programs

A folk theorem on repeated games assures that for sufficiently high values of the time discount factor all firms prefer being able to enforce a collusive agreement rather than doing business in a perfectly competitive market.[2]

Nevertheless, competition law prevents collusive agreements from being legally binding, making any agreement among competitors to increase total profit at the expense of customers void. Thus, for the unenforceable anticompetitive behaviour to arise in equilibrium under competition law, firms need be able to tacitly coordinate.

Firms incentive to coordinate their strategies however collides with two fundamental problems. On the one hand they need agree upon agreement terms. On the other hand, once reached the agreement,

[2]Friedman 1971.

some disciplinary tool is necessary to avoid opportunistic behaviours.[3]

For this reason the analysis of collusion in modern economics is based on incentive compatibility constraints: each firm has to compare the immediate gain from deviating with the profit it gives up in the future, when rivals react.

If antitrust authorities had full information about the firms conduct, no proceeding costs, or no constraint on fines, their optimum strategy would be straightforward: a sufficiently high expected sanction would induce profit maximizing firms to behave competitively. Thus, the formation of cartels would be prevented.

However, a welfare maximising legislator is not typically willing to invest in enforcement the amount of resources necessary to completely deter the unlawful activity.[4] The study of antitrust enforcement appears interesting because authorities do face informative constraints, limited resources and finite fines.

If in such a situation an authority can not increase the expected fine to its beckerian level, the only way it has to enforce antitrust law under the budget constraint is to create incentives for cartel members to play one against the other.

The way leniency programs improve the enforcement of competition law is exactly by providing cartelists with private incentives to voluntarily supply information on their misconduct.

If firms facing the opportunity to set up a cartel realize that any accomplice will deviate from the agreement, they face a higher probability of conviction and thus are less likely to start colluding in the first place.

3.1 The Model

To create scope for the antitrust authority to implement a leniency program, I build on the model of Besanko and Spulber (1989).

Thus, I consider an industry where n identical risk-neutral firms supply an homogeneous good by simultaneously setting prices $p_s = 1, .., p_n$.

[3]Stigler (1964)

[4]Becker (1968).

Firms have no fixed costs of production and the common marginal cost $\theta_i \in \{\theta_1, ..., \theta_n\}$ is privately known by the industry. The authority assigns a probability $\mu_i \in (0,1)$ to $\theta = \theta_i$.

The industry output q is observable and the inverse demand function $p(q)$ is common knowledge.[5] Thus, prices are known to the legislator.

Due to the test burden typical of antitrust trials, I assume it is not possible for a competitive firm to be condemned - i.e., there are not type I errors.

The market is assumed to clear with a positive amount of trade q^{nc} at the competitive price level $p_i^{nc}(q) = \theta_i$.

Firms maximize the expected sum of their profits, discounted by a common time discount factor $\delta \in (0,1)$. They choose whether to compete or collude and are able to sustain a cartel by adopting a grim trigger strategy à la Friedman (1971).

An unilateral deviation from the collusive price p^c triggers a switch to perfect competition forever after, so reproducing the static Bertrand's equilibrium $p_i^{nc} = \theta_i$. Each firm s prices in an industry of type i:

$$\begin{aligned} p_s(t) &= p_i^c \quad \text{if} \quad p_{s'}(t-1) = p_i^c \;\; \forall s' \neq s, \\ p_s(t) &= p_i^{nc} \quad \text{if} \quad p_{s'}(t-1) \neq p_i^c \;\; \exists\, s. \end{aligned}$$

Thus, every deviation from the cartel strategy means no collusion in the subsequent periods, that is the non cooperative Bertrand-Nash static equilibrium.

The instantaneous profit of a i-type firm is in each period:

$$\pi_i^c \equiv [p^c - \theta_i]\frac{D(p^c)}{n}$$

if all firms collude;

$$\pi_i^{nc} \equiv [p_i^{nc} - \theta_i] D(p_i^{nc})$$

if all firms compete or if firm i colludes while another deviates;

$$\pi_i^d \equiv [(p^{nc} - \varepsilon) - \theta_i] D(p^{nc} - \varepsilon)$$

[5]This assumption makes information uniform among cartelists and rules out problems of secret undercutting, delay in observation and accidental price wars.

if it deviates and the others collude, assuming that a deviating firm is able to sell a quantity arbitrarily close to the non-competitive level.

Firms collude if this yields positive profits net of expected penalties from price fixing. Given the cartel profit maximization, the retaliation strategy, and the homogeneity of traded goods:

$$\pi_i^d > \pi_i^c > \pi_i^{nc} = 0.$$

Being this framework analogous to Bertrand's oligopoly with perfect information among competitors, the study of collusion with a finite time horizon is void of interest.

In an infinitely repeated game firms must consider the possibility of incurring long period losses when deviating from the agreement.

The threat of retaliation calls for the analysis of subgame perfect equilibria in the infinitely repeated collusive game played by firms.

3.2 No competition policy

In the benchmark scenario firms have the opportunity to collude and fix a common price above marginal cost, without any attempt by the legislator to deter or suppress such activity. The legislator simply delegate the economic activity to firms, without constraining their behaviour.

The ability to sustain collusion among firms as a subgame perfect Nash equilibrium depends on the alternative strategies.

If all firms collude, each cartelist earns a sum of discounted profits

$$\begin{aligned} V_{f,i}^c(p_i, \theta_i) &= \sum_{t=0}^{\infty} \delta^t \pi_i^c \\ &= \frac{\pi_i^c}{1-\delta}, \end{aligned}$$

since $\delta < 1$.

If firms do not coordinate their strategies, their discounted payoff is

$$V_{f,i}^{nc}(p_i, \theta_i) = \sum_{t=0}^{\infty} \delta^t \pi_i^{nc}$$

Whilst a firm that deviates when the others are adopting the collusive strategy earns

$$V_{f,i}^{d}(p_i,\theta_i) = \pi_i^d + V_{f,i}^{nc}(p_i,\theta_i)$$

A cartel is self-sustainable if and only if firms have no incentive to unilaterally deviate from the cartel strategy. Thus, the incentive compatibility constraint for firms to collude is:

$$\frac{\pi_i^c}{1-\delta} \geq \pi_i^d.$$

It is almost common wisdom that, for sufficiently high values of the discount factor

$$\delta \geq \delta^* \equiv \left(1 - \frac{\pi_i^m}{\pi_i^d}\right), \qquad (1)$$

firms are able to set up self-enforcing cartels and thus collude even in lack of binding agreements.

In a dynamic oligopoly *à la* Bertrand with grim trigger strategy, every amount of collusive profit resulting by arranged prices between the perfect competitive and the monopolistic ones can constitute an equilibrium for sufficiently high values of the discount rate.

3.3 Collusion in the presence of an antitrust authority

Having analyzed sustainability of collusion in absence of competition law, I introduce the prohibition of collusive agreements.

A veto on cartels comes from the maximization of the legislator welfare function:

$$V_{S,i}(\theta_i, p_i) = S + \int_0^{p_i} D(x)dx - \theta_i D(p_i), \qquad (2)$$

where S denotes the preference of the legislator for private firms carrying out the economic activity, and the integral is the social gain from trade.[6]

[6]If S is small or not present, the legislator prefers performing the economic activity by mean of the public sector.

Having cartels the sole effect of decreasing social welfare in the model, such activity has to be forbidden. Nevertheless, the veto conflicts with the incentive of profit maximizing firms.

I follow Besanko and Spulber (1989) by labelling firms choice between competing in prices and forming a cartel with the boolean variable $K = \{0, 1\}$ that takes value 1 when firms set up a cartel, and 0 when they behave competitively.

Competition law is enforced by an antitrust authority that internalizes the legislator objective function and does not directly observe cartel formation.

In order to convict a cartel it is necessary to perform costly investigations. This yields to condemn existing cartels only with a certain probability α, endogenously determined by balancing costs and gains from investigation.

The total cost of carrying out an investigation increases with the desired probability of conviction and amounts to $C\alpha(p_i)$.

The function $\alpha(p_i)$ is chosen by the legislator according to its preferences. It maps prices into probability of conviction, determining the amount of resources devoted to the investigative activity and hence its effectiveness.

Thus, the authority commits to a set of policy parameters $\{\alpha(p_i), F\}$ and optimizes

$$\max_{\alpha(p_i),F} \sum_{i=1}^{n} \mu_i \quad \Big\{ K_i \left[V_i^L(\theta_i, p_i^c) - C\alpha(p_i^c) \right] + (1 - K_i) \left[V_i^L(\theta_i, p_i^{nc}) - C\alpha(p_i^{nc}) \right] \Big\} \qquad (3)$$

Where the parameter F denotes the fine imposed to a firm proven guilty and is seen by the authority as a pure transfer between firms and consumers.

The value for F is constrained to a finite amount $F \in [0, A)$ where A is the limited liability of each firm. It is thus not intended that firms go bankrupt because of the fines they have to pay.

Being prices and demand perfectly observable by the authority, the latter has the opportunity to convict with probability $\alpha(p > p_i^c) = 1$ any cartel but those set up by a θ_i-type industry which mimics the competitive behaviour of a $\theta_{i'}$−type competitive industry, where $i < i\prime$.

To keep the model simple I analyse an economy with two possible types of industry: $i = 1, 2$.

The Authority has to choose two levels of price p_i^*, one for each possible type of industry $i = 1, 2$, which label an industry's conduct as "suspect".

Whenever $p = p_1^{nc}$, since a high-cost industry has no incentive to mimic a low-cost competitive one, the authority knows that the market is competitive. Nevertheless a high price $p = p_2^{nc} = \theta_2$ can be sign of a high-cost competitive industry, the authority cannot be sure whether that is the consequence of a collusive agreement in a low-cost industry.

Assuming that the authority has complete bargaining power, it can impose the following contract to firms in the industry:

"Firms can run economic activities without any public intervention. The authority will monitor their behaviour. If it finds that the price mechanism works without collusion nothing happens; if instead the price p_i rises suspects of a collusive agreement, the authority will be able to convict all cartelists with probability α, whenever a cartel exists, and to impose a fine F".

The timing of the game is as follows:

1. The authority sets parameters $\{\alpha(p_i), F\}$.
2. Firms, known the values $\{\alpha(p_i), F\}$, choose between to collude or not and, in the first case, whether to deviate or not.
3. The authority monitors markets and applies its commitment, condemning cartels active in the previous period with probability $\alpha(p_i)$ and charging each cartelist a fine F.

The game is repeated until the authority finds the cartelists guilty by mean of its investigation, so that the flow of collusive payoffs ends.

If the Authority had full information it could totally deter cartelisation by charging firms of type θ_i that produce less than q_i^c a fine

$$F = \pi_i^m,$$

so that firms never choose to collude.

However, as mentioned earlier, the authority faces the two difficulties of limited resources and imperfect information. Because resources are limited it cannot monitor markets with such a wideness and accuracy that all cartels are convicted.

The contract between the Authority and firms is incentive compatible if it induces firms not to collude and it ensures their participation to the economic activity.[7]

The authority maximises total welfare (3) subject to:

$$(p_i, K_i) = \arg\max_{p_i, K_i} K_i \left[V^f(p_i, \theta_i, \alpha_{[p_i]}, F) \right] \qquad (IC_i)$$

$$K_i \left[V^f(p_i, \theta_i, \alpha_{[p_i]}, F) \right] \geq 0 \qquad (IR_i)$$

$$F \leq A \qquad (LL)$$

Because fines are not a cost to the society, it is always optimal for the authority to set them as big as possible at the level of firm's limited liability A, thus $F = A$.

In fact, risk neutral firms take their decisions about collusion on the basis of their expected punishment $\alpha(p_i)F$. Thus, for any value of the costly instrument $\alpha(p_i)$, the authority prefer to give F the highest possible value to reduce the incentive of firms in colluding.

The contract does not affect the participation constraint (IR), as each firm has the opportunity to play in a competitive way and avoid fines to obtain the reserve profit assumed to be zero.

Thus, the participation constraint is satisfied and it is possible to focus on incentive compatibility constraints. The authority faces the following contract design problem:

$$\max_{\alpha(p_i), F} \sum_{i=1}^{2} \mu_i \left\{ K_i \left[V_i^L(\theta_i, p_i^m) - C\alpha(p_i^m) \right] + (1 - K_i) \left[V_i^L(\theta_i, p_i^c) - C\alpha(p_i^c) \right] \right\}$$

[7] Laffont and Martimort (2002)

subject to:

$$(p_i, K_i) = \arg\max_{p_i, K_i} K_i \left[V^f(p_i, \theta_i, \alpha(p_i), A) \right] \qquad (IC_i)$$

The firms incentive compatibility constraints are those typical of a problem of adverse selection.

In fact, an industry with cost θ_i can mimic the conduct of a competitive industry with cost $\theta_{i'}$ for $i \neq i'$ in order to pool with a competitive $\theta_{i'}$-type industry.

In the simple case with only two cost-types, the authority has to decide between the fully competitive outcome and the opportunity of allowing a low-cost industry to collude.

If the Authority wants a *fully competitive* outcome the incentive compatibility constraints in the design problem for the Authority write as:

$$\begin{aligned} V^d_{f,1}(p_1^{nc}, \theta_1, \alpha(p_1^{nc}), A) &\geq V^c_{f,1}(p_2^c, \theta_1, \alpha(p_2^{nc}), A) \\ V^d_{f,2}(p_2^{nc}, \theta_2, \alpha(p_2^{nc}), A) &\geq V^m_{f,2}(p_1^{nc}, \theta_2, \alpha(p_1^{nc}), A) \end{aligned}$$

That is:

$$\pi_1^d - \alpha(p_2^c)A \geq \left(\frac{\pi_{1,2}^m - \alpha(p_2^c)A}{1-\delta} \right) \qquad (4)$$

$$\pi_2^d - \alpha(p_1^c)A \geq \left(\frac{\pi_{2,1}^m - \alpha(p_1^c)A}{1-\delta} \right) \qquad (5)$$

where $\pi_{i,j}^m = [p_j^{nc} - \theta_i] \frac{D(p_j^{nc})}{n}$ is the profit of a collusive type-i firm that mimics a competitive type-j firm.

Since type-2 firms would incur in losses by mimicking a competitive type-1 firm, constraint (5) is not binding.

In order to discourage firms from mimicking other types it is sufficient to set $\alpha(p_1^{nc}) = 0$, and to make (4) satisfied by carrying out an investigation, whenever market price is above p_2^{nc}, so that the probability of individuation and conviction is:

$$\begin{aligned}\alpha(p_2^{nc}) &= \frac{\left[\frac{\pi_{1,2}^m}{1-\delta} - \pi_1^d\right]}{A\left(\frac{1}{1-\delta}\right)} \\ &= \frac{1}{A\delta}\left[(\theta_2-\theta_1)D(p_2^c)-(1-\delta)\pi_1^d\right] \end{aligned} \tag{6}$$

The first term in brackets of equation (6) is increasing in the informational firms have about their cost. This comes from the adverse selection problem between the authority and firms. The second term has a decreasing effect on α (thus on the amount of resources to be devoted to the Authority) and comes from the destabilizing effect of moral hazard between firms.

The policy specified in equation (6) prevents a type with cost greater or equal to $\theta_1$from colluding and mimicking a high cost type.

Of course the authority has to trade off the cost of such a police with the benefit to the legislator.

However, the folk theorem on repeated games still applies. Finite values of α do not prevent collusion for sufficiently high values of the time discount factor. Collusion is profitable with an antitrust authority for values of the dime discount factor

$$\delta \geq \delta_{aa}^* \equiv 1 - \frac{\pi_{1,2}^m - \alpha(p_2^{nc})A}{\pi_i^d - \alpha(p_2^{nc})A}. \tag{7}$$

The collusive-friendly value for δ in inequality (7) is more restrictive than the one derived without antitrust enforcement in inequality (1). Yet, collusion can be incentive compatible.

3.4 Collusion in the presence of leniency programs

The activity of an antitrust authority reduces the expected profit from colluding and thus the presence of cartels in the economy. Firms need a larger gap between profit from collusion and from deviation as $\alpha(p_2^c)$ increases. By increasing the strength of the authority the firms incentive compatibility constraint becomes more and more binding.

However, as was pointed out by Besanko and Spulber (1989), the authority will find suboptimal, under asymmetric information, to completely deter collusion by mean of its costly investigative activity.

As long as inequality (7) is satisfied, firms agree upon the optimality of the collusive behaviour and face the fine F imposed by the authority with probability $\alpha(p_2^c)$.

The authority can nevertheless exploit the moral hazard problem at the cartel level, relying on the incentive for each firm to deviate from the collusive agreement.

Leniency programs modify the contract between authority and firms through the introduction of a direct revelation mechanism able to exploit the information shared among firms about their common shock on costs.

Despite the legislator lack of inclination to increase the amount of resources devoted to enforcement, a well-arranged leniency program can transform the choice on the formation of cartels in a sort of Prisoner's dilemma able to deter collusion.

As pointed out by Spagnolo (2004), "agents involved in organized crime are in a Prisoner's Dilemma-like situation already without the leniency program, since each of them can cheat on the others running away with the money. But typically the situation is repeated, and criminal/collusive agreements can be sustained by reputational forces. What leniency programs do is changing the payoffs in this dynamic game, so that the choice between colluding and defecting-and-reporting again looks similar to a *static* Prisoner's Dilemma." (Italic added).

Under some conditions, implementing a leniency program in the economy switches the result of the game from cooperation to deviation, so that existing cartels disappear and no new equally profitable cartels are arranged.

What matters for this purpose is that each cartelist disposes of hard information useful for the authority to individuate and convict a collusive agreement.

The literature on leniency programs analyses the functioning of these tools looking for Nash equilibria. The incentive a firm has to unilaterally deviate is the key to the effectiveness of any deterrent tool.

A mechanism able to work under these assumptions is that where the Authority picks randomly in each period a firm on the market and is able to impose the following mechanism:

"Firms can run economic activities without any public intervention. Being the authority uncertain about the free working of the price mechanism, in markets that are supposed to have high costs it offers to a randomly picked firm to confidentially confess the involvement in a collusive agreement directed to mimic an higher cost-type competitive firm. If the firm confesses it will be charged a fine$(1-\beta)F$. If not, the authority monitors the market and with probability α charges every cartelist of a fine F, provided that an agreement exists. If there is not collusion, nothing happens"

The timing of the game, having introduced such selective leniency program, writes as follows:

1. The authority sets parameters $\{\alpha, F, \beta\}$.
2. Firms know the values $\{\alpha, F, \beta\}$ and decide whether to collude or not. If they decide to collude, evidence is produced.
3. The authority picks randomly a firm from the market and proposes it to obtain leniency.
4. The chosen firm decides whether to deviate or not and if to reveal or not.
5. If the selected firm has revealed the existence of a cartel its partners are condemned, the authority charging the whistle-blower a fine $(1-\beta)F$ and all others cartelists the whole fine F. If not, the Authority monitors the market, succeeding in condemning an existent cartel with probability α and charging every cartelist of a fine F.

The game repeats until the authority finds guilty cartelists, by mean of its investigation or because a firm confesses, so that the flow of collusive payoffs ends.

I assume that whenever a firm confesses the collusive agreement the authority is able to gather the evidence that is necessary to condemn the cartel. This assumption is dropped in the following section, where I address the issue of firms bringing non-deciding information.

The expected punishment faced by a firm that confesses is the reduced fine

$$P^L = (1-\beta)A$$

and its expected payoff from applying for leniency is thus:

$$V^L_{f,i} = \pi^d_i - (1-\beta)A \tag{8}$$

Therefore, firms do not collude in the presence of a leniency policy whenever

$$V^L_{f,i} > V^c_{f,i} \tag{9}$$

that is:

$$\frac{\pi^m_{1,2} - \alpha A}{1-\delta} \leq \pi^d_1 - (1-\beta)A \tag{10}$$

The folk theorem still applies. However, collusion is now incentive compatible only for values of the time discount factor

$$\delta \geq \delta^*_L \equiv 1 - \frac{\pi^c - \alpha A}{\pi^d - (1-\beta)A} \tag{11}$$

Lemma 1 *A leniency program is able to enhance the breakdown of cartels. In fact, from inequality (11) and (7)*

$$\beta > 1 - \alpha \Leftrightarrow \delta^*_L > \delta^*_{aa}$$

In this framework, the effect of a leniency program on cartel deterrence is unambiguosly positive. The Authority improves deterrence by adopting a leniency program, without involving any additional resource.

Nevertheless, the result pointed out in Spagnolo (2000) is confirmed in the present model: moderate leniency programs - i.e. those with $\beta \leq 1$ - do not help to deter collusion.[8]

Proposition 1 *Reliefs from penalties have no effect on deterrence.*

[8] All programs in real world, but (explicitly) the Korean and (implicitly) the American one, are moderate.

Proof. *Collusion is unsustainable if and only if the expected profit obtained with a lenient conviction is higher than the discounted profit from colluding. From inequality (10), this holds whenever*

$$\beta \geq 1 + \left[\left(\frac{\pi^m_{1,2} - \alpha F}{1-\delta} \right) - \pi^d_1 \right] \frac{1}{F} \tag{12}$$

The incentive compatibility constraint (12) has a vertical intercept at $\beta = 1$. *Under the participation constraint,*

$$\left(\frac{\pi^m_{1,2} - \alpha F}{1-\delta} \right) - \pi^d_1 > 0.$$

Thus, the firms incentive compatibility constraint always requires a discount $\beta > 1$ *to deter collusion.*[9] ■

4 Leniency to the followers

It was hitherto assumed that a report by one informer is sufficient for the authority to get the cartel sentenced.

If this is the case, it is always optimal for the authority to grant leniency only to one firm: allowing other firms to get a reduced fine would amount to granting partial immunity, without any improvement in cartel deterrence.

While most models on leniency assume that the admission of one firm results in the cartel being convicted, one piece of evidence may be not enough to establish that an anticompetitive agreement was in place.

In order to explore this feature of law enforcement I modify the kind of evidence cartelists hold in the model. I assume the information that matters for the authority to convict colluding firms is uniformly split among cartelists in pieces of disjoint information.

Each firm is able to produce one piece of evidence, that increases the probability of individuation and conviction, but a firm-specific ev-

[9]Spagnolo (2000) proves that a "courageous" leniency program (i.e. one that grant rewards to self-denouncing firms) leads to first best under the Authority's self-financing constraint.

idence is not sufficient for the authority to get the cartel sentenced.

In such a framework, the authority may find convenient granting $l > 1$ firms with leniency, to increase the probability of conviction ex ante and deter the formation of otherwise profitable cartels.

The probability of conviction $\alpha(l)$ increases with the number of firms that gain access to the program:

$$0 < \alpha(0) < \alpha(1) < ... < \alpha(n) = 1$$

Of course such instrument can be a double-edged sword. Granting leniency, after the authority has acknowledged the collusive agreement, decreases the sanction expected by firms who did not come first to the doorstep of the authority.

This may determine a waiting game whereby no firm has incentive to move in the first place. If leniency to the followers had this effect, this would undermine the effectiveness of the program as a deterrent.

The authority must thus consider the amnesty effect caused by the opportunity for $l > 1$ firms to get the lenient fine. The increase in the probability of conviction and decrease of prosecution costs brought by additional leniencies can offset this perverse effect. To assure that this is the case the optimal program must meet some qualification, as I shall show in what follows.

4.1 The coordination game when $l > 1$

I analyse the optimality of granting leniency to $l > 1$ firms in the simplest possible model. Assume that the authority has the opportunity to commit to a set of parameters $\{\alpha, F, \beta, \gamma\}$ where γ is the relief from fines to the second applicant who applies for leniency.

The timing of the game is as follows:

1. The authority sets parameters $\{\alpha, F, \beta, \gamma\}$.
2. Firms know the values $\{\alpha, F, \beta, \gamma\}$ and decide whether to collude or not. If they decide to collude, evidence is produced.
3. Firms decide whether to report to the authority or not. The first firm that decides to report entitles to a discount β if the cartel is convicted.

4. The second firm realizes before getting to the authority that an other firm was already eligible to the first leniency, and decides whether to report its evidence to secure a discount γ.

5. If on the basis of all collected evidence the authority is able to get the cartel sentenced, it charges the first informer (if any) a fine $(1-\beta)F$, the second (if any) a fine $(1-\gamma)F$, and all others cartelists the whole fine F.

The game repeats until the Authority finds guilty cartelists, so that the flow of collusive payoffs ends.

Since prices are observable, the coordination among firms is a two-stage game. First, any firm has the opportunity to deviate from the collusive agreement and apply for the leniency program.

After a firm deviated and applied for the lenient fine, other cartelists know that one piece of information was delivered to the authority. Hence, they face a higher probability of conviction, have a lower probability to get any discount, and must give up the possibility of gaining the profits from deviation.

Figure 2 at the end of the paper shows the extensive form of the game played by colluding firms. This is resolved by backward induction. Starting from the second stage, firms that observe the deviation of an accomplice from the collusive agreement have to choose among the following moves and related payoffs.

A firm that reports when all other accomplices deviate from the cartel faces the probability of conviction $\alpha(2)$, determined by the two pieces of information the authority receives. It has only one probability out of the remaining $(n-1)$ cartelists to get the discount to the second informer. Thus, its pay off is:

$$y_O^A = \frac{-\alpha(2)[(1-\gamma)F-(n-2)F]}{n-1},$$

where y stands for "$y$es report", A for "All other deviate" and O for "One piece of information held by the authority". In what follows, n labels "no report", N stands for "No other deviates" and Z means that "Zero pieces of information" were previously given to the authority.

If the firm decides not to deviate whilst all other cartelists do so, it faces the full expected fine, with the authority having access to two pieces of information about the cartel:

$$n_O^A = -\alpha(2)F.$$

If the firm chooses to deviate when no remaining cartelist deviates, it gets for sure the lenient fee when the authority is able to convict the cartel. Given that the authority holds two pieces of information, its payoff is thus

$$y_O^N = -\alpha(2)(1-\gamma)F.$$

Finally, if no accomplice reports at the second stage and the firm keeps colluding it expects a payoff:

$$n_O^N = -\alpha(1)F.$$

The equilibrium in the second stage of the game, when a first cartelist deviated, depends on the discount γ available to the second informant.

Thus the authority can choose a γ such that firms prefer to bring additional information useful to the investigation.

Lemma 2 *The authority is always able to set a discount γ on fines that is sufficient for the second informer to find reporting a dominant strategy. In fact,*

$$\gamma > \underline{\gamma} = 1 - \frac{\alpha(1)}{\alpha(2)} \;\Rightarrow\; y_O^j \succ n_O^j,\; j = A, N. \tag{13}$$

The marginal informativeness of firms evidences plays a primary role in the optimal set up of the leniency program.[10]

Having showed that the authority has full power on whether firms will report at the second stage after a deviation is detected, I now turn to analyze the first stage of the game, which is equivalent to the second stage when no firm had previously reported.

A firm that sees no accomplice deviated from the collusive agreement knows how other firms react to its decision, depending on the discount γ set by the authority.

[10]In the following subsection I give a different interpretation to this relationship, explaining the authority optimal choice in terms of its abilities rather than with the exogenous informativeness of firms cooperation.

If the authority decided to make reporting the optimal action for firms in response to the first deviation, a cartelist who knows that no accomplice reported beforehand has to make its decision upon the following set of payoffs.

If the firm reports when all others do the same, it has one chance over n to be the first at the doorstep of the authority, one chance of being the second applicant, and $n-2$ of loosing the race. Hence, it expects:

$$y_Z^A = \frac{\pi^d - \alpha(2)[n-\beta-\gamma]F}{n}.$$

If the firm does not report whilst all other firms do so, it faces the whole fine with a probability of conviction that hinges on two pieces of information:

$$n_Z^A = -\alpha(2)F.$$

If the firm deviates alone, it is sure to get the lenient fine in case of conviction. However, it knows that other cartelists are given incentive to report additional information at the following stage. Thus, even though it knows it will be the first applicant, the probability of conviction it faces relies on two pieces of information:

$$y_Z^N = \pi^d - \alpha(2)(1-\beta)F.$$

If no firm deviates, the expected payoff is that typical of the economy without leniency program:

$$n_Z^N = \frac{\pi^m - \alpha(0)F}{1-\delta}.$$

To report is always an optimal action if all other firms do so. If all other firms keep colluding, the decision depends on the value β set by the authority.

Report is the subgame perfect Nash equilibrium in the first stage whenever

$$\beta \geq 1 + \left[\left(\frac{\pi_{1,2}^m - \alpha F}{1-\delta}\right) - \pi_1^d\right]\frac{1}{\alpha(2)F}. \tag{14}$$

The critical value for the discount β does not depend directly on γ.

Nevertheless, when the authority sets the lenient fine to followers so that they prefer to report, the ex-post higher probability of conviction induces the first mover to apply for leniency ex ante with a fine discount β lower than in the case where no other cartelist has the opportunity to join the program.

Thus, when the authority allows $l > 1$ firms to the leniency program, and give them a sufficiently high fine discount specified in (13), the effect on the coordination game between firms is unambiguously positive.

There does not seem to be any danger related with the adoption of a leniency program allowing $l > 1$ firms to benefit from leniency. However, this result holds because firms were supposed to set up cartels with the sole objective of gaining an infinite stream of collusive profit thereafter, all parameters kept *constant*, as is generally the case in the literature on antitrust.

Firms can not exclude the possibility that parameters like the probability of conviction, the market demand and the production technology can change in the future and make collusion no longer profitable.

Yet, as long as the date of such a change is unknown, cartelists can only form an expectation over whether and when the stream of collusive profits will stop.

When such a change happens, leniency programs constitute a useful tool for firms to forget their misconduct and the corresponding fine. Stephan (2009) suggests that the increase in cartel conviction after the adoption of a leniency policy is a signal of improved ex post desistance. The empirical evidence collected by Stephan is supported by the theoretical model.

Lemma 3 *A leniency program acts as a safe-conduct for firms to leave the collusive agreement without having to pay for the former illegal behaviour. It fosters ex-post desistance from cartels that are not profitable anymore.*
Proof. *A colluding firm can be convicted for anticompetitive behaviour even after a deviation. Thus, a collusive agreement that before changes in δ was profitable even under leniency because*

$$\frac{\pi_{1,2}^{m} - \alpha F}{1-\delta} \geq \pi_1^d - \alpha(1)(1-\beta)F$$

after a change to $\delta' < \delta_L^*$ could still fulfil the incentive compatibility constraint without leniency

$$\frac{\pi_{1,2}^m - \alpha F}{1-\delta'} \geq \pi_1^d - \frac{\alpha F}{(1-\delta')}$$

but violate the constraint for colluding under leniency with the new discount factor

$$\frac{\pi_{1,2}^m - \alpha F}{1-\delta'} < \pi_1^d - \alpha(1)(1-\beta)F.$$

■

Lemma 4 *Ex-post desistance may undermine ex-ante deterrence. Opening the program to $l > 1$ firms can worsen this problem by creating a waiting game among applicants.*

Proof. *Assume that firms assign a probability distribution $f(\delta)$ to the value the time discount factor.*[11] *They know that if in the future the time discount factor falls below $\underline{\delta}$ the cartel becomes unstable. Furthermore, they know the probability $f(\Delta)$ that δ falls below its critical value over time. It is possible that a leniency program limited to one firm - i.e. whereby $l = 1$ - is able to deter the formation of a cartel:*

$$\begin{aligned} \pi^d - \alpha(1)(1-\beta)F \quad \geq \quad & \int_0^{\Delta}\int_{\underline{\delta}}^{1} \delta^t\left(\pi^m - \alpha F\right) f(\delta) d\delta f(\Delta) d(t) \\ & + \int_0^{\underline{\delta}} \delta^k \left(\frac{\pi^d - \alpha(1)(1-\beta)F}{n} - \frac{(n-1)\alpha(1)F}{n}\right). \end{aligned}$$

Whereas by adding a second discount to a follower - i.e. $l = 2$ - the author-

[11]Without any loss of generality I focus on changes in the value of the time discount factor. Any other possible change in the profitability of collusion - e.g. change in consumers demand, technological shocks, new entrants - is equivalent to a change in the discount rate when all other variable are kept constant.

ity stabilizes the collusive agreement:

$$\pi^d \quad - \quad \alpha(1)(1-\beta)F < \int_0^{\Delta}\int_{\underline{\delta}}^{1} \delta^t (\pi^m - \alpha F) f(\delta) d\delta f(\Delta) d(t)$$

$$+ \quad \int_0^{\underline{\delta}} \delta^k \left(\frac{\pi^d - \alpha(2)(1-\beta)F}{n} - \frac{\alpha(2)(1-\gamma)F}{n} - \frac{(n-2)\alpha(2)F}{n} \right).$$

In particular, this is the case whenever

$$\gamma > \bar{\gamma} = \left(1 - \frac{\alpha(1)}{\alpha(2)}\right)(n-\beta) \tag{15}$$

■

Thus, high values of γ provide cartelists with an opportunity of future amnesty that makes collusion more profitable in expected terms.

Corollary 5 *A courageous leniency program makes the implementation of the program for followers more difficult by increasing the amnesty effect of the program as a whole. In fact, from inequality (*15*), as β increases the lenient sanction to the follower more easily induce firms to play the waiting game.*

Corollary 6 *Larger cartels are relatively less subject to the waiting game. In fact, as n increases, the amnesty effect is divided among more firms and has a lower weight on their choice.*

There is a trade off between the formation of some otherwise unprofitable cartels and the granting of leniency to obtain valuable information by the followers.

Proposition 2 *An authority that finds difficult to get detected cartels sentenced can successfully implement a moderate leniency programs for followers by setting a discount*

$$1 - \frac{\alpha(1)}{\alpha(2)} < \gamma < \left(1 - \frac{\alpha(1)}{\alpha(2)}\right)(n-\beta). \tag{16}$$

Proof. *The proposition stems directly from lemmata (2) and (4).* ■

The way the probability of conviction depends on the number of firms bringing evidence to the authority plays a crucial role in the optimality of the program.

4.2 Authority abilities and optimal leniency

To further analyze the desirability of granting leniency to followers in the race to the authority, I introduce a probability of detection *and* conviction $\alpha(l)$ that depends on the number of firms asking for leniency, each with its piece of information about the cartel.

Antitrust authorities in different countries have different abilities in detecting and convicting cartels because of legislative differences, amount of resources devoted to investigations, market structures and cultural norms.

I formalize the mapping between the number l of applicants for leniency from a cartel and the probability of detection and conviction by introducing a measure of probability $\alpha(l)$ such that:

$$\begin{aligned}\alpha(0) &= \underline{\alpha} \\ \alpha(n) &= 1.\end{aligned}$$

Where $\underline{\alpha}$ denotes the probability of individuation and conviction in the absence of a leniency policy.

In order to capture the impact pieces of information have on different authorities, I assume

$$\alpha(l,\rho) = \left(\frac{l+z}{n+z}\right)^{\rho}, \tag{17}$$

where $z > 0$ is an exogenous parameter defining the ability of an authority in condemning cartels without making use of a leniency program.

The parameter $\rho > 0$ is an index of the marginal ability of informers to increase the probability of conviction of cartels, compared to the improvement given by the subsequent ones.

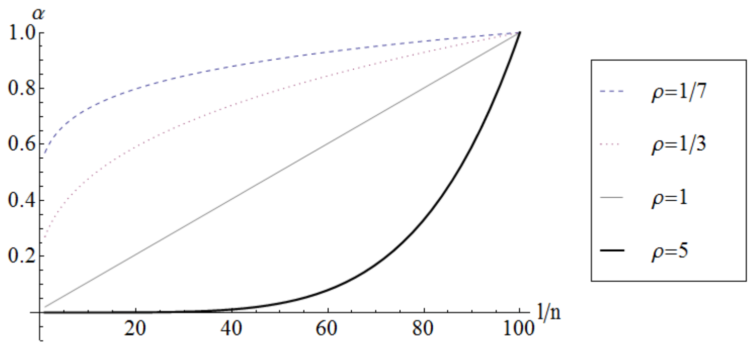

Figure 1: Reaction of α to changes of l for different values of ρ.

If $0 < \rho < 1$:

$$\frac{\partial \alpha}{\partial l} > 0 \text{ and } \frac{\partial^2 \alpha}{\partial l^2} < 0,$$

the first applicant leads the higher improvement in α;

If $\rho > 1$ then

$$\frac{\partial \alpha}{\partial l} > 0 \text{ and } \frac{\partial^2 \alpha}{\partial l^2} > 0,$$

it is only with the report from followers that the contribute of the program on the probability of conviction becomes appreciable.

Figure 1 shows the shape of $\alpha(l)$ for different values of ρ.

A natural interpretation for ρ is in terms of authority's relative ability in detecting cartels by monitoring markets, compared to how easily it gets an detected cartel convicted.

High values of ρ are typical of an authority that finds difficult obtaining the conviction of a detected cartel, relatively to understanding that a cartel is active in the economy.

Thus, a high parameter ρ makes the evidence brought by first applicants ineffective, and assigns relatively greater importance to the arrival of pieces of heterogeneous information to gather conclusive evidence over the breach of competition law. Obviously, the opposite is true for low values of ρ.

The intuition underlying ρ is more easily understood if the parameter is split into two terms:

$$\rho \equiv \frac{\lambda}{\omega},$$

where:
$\omega =$ ability of the Authority in condemning detected cartels.
$\lambda =$ ability of the Authority in detecting cartels.

That is, ω gives the prominence of improving α after detection (collection of evidences). Instead, λ is the prominence of improving α during the former phase (individuation of an agreement).

In this framework, granting leniency to a number of firms $l > 1$ leads to different results depending on the ability of the authority.

All results showed in Section 3 are confirmed under the new definition of α. In particular, the incentive compatibility constraint for a firm to unilaterally deviate from a cartel when only one firm is allowed to the program becomes:

$$\frac{\pi_{1,2}^{m}}{1-\delta} - \frac{\left(\frac{z}{n+z}\right)F}{(1-\delta)} \leq \pi_1^d - \left\{\left(\frac{1+z}{n+z}\right)^{\rho}(1-\beta)F\right\}$$

Hence:

$$\beta \geq 1 + \frac{\left[\frac{\pi_{1,2}^{m}}{1-\delta} - \frac{\left(\frac{z}{n+z}\right)F}{1-\delta}\right] - \pi_1^d}{\left(\frac{1+z}{n+z}\right)^{\rho} F}, \tag{18}$$

and a moderate program does not deter collusion.

However, the new specification of $\alpha(l)$ allows analysing the same game of Section (4.1) above, taking into account how the authority specific ability ρ affects the implementation of an optimal program.

Proposition 3 *Authorities that need additional evidence to convict a cartel must propose a high discount γ to induce followers to apply for leniency.*
Proof. *From Lemma* 2 *and the definition of probability of conviction in equality (*16*), the lower value for any authority to make followers report is*

$$\underline{\gamma} = 1 - \left(\frac{1+z}{2+z}\right)^{\rho},$$

that increases as the antitrust need for additional evidence increases:

$$\frac{\partial \underline{\gamma}}{\partial \rho} = -\left(\frac{1+z}{2+z}\right)^{\rho} \ln\left(\frac{1+z}{2+z}\right) > 0. \tag{19}$$

■

Proposition 4 *A leniency program opened to followers is not only unnecessary to an authority who does not need additional evidence to increase the probability of conviction, it is even potentially dangerous. This is especially true when the program rewards the first informer.*
Proof. *Notice that*

$$\bar{\gamma} = \underline{\gamma}(n - \beta). \tag{20}$$

Thus,

$$sgn\left(\frac{\partial \bar{\gamma}}{\partial \rho}\right) = sgn\left(\frac{\partial \underline{\gamma}}{\partial \rho}\right) > 0$$

and an authority with low ρ faces a stricter constraint (15) to avoid the waiting game. From equality (20) it is clear that the constraint is particularly restrictive for authority granting a higher discount β. ■

It is therefore possibly optimal for an authority to grant leniency to a number of firms $l > 1$. This does not necessarily harm ex ante deterrence. Nevertheless, the authority has to consider the impact of the additional information on its probability to get the cartel sentenced and choose its leniency policy accordingly.

5 Conclusions

The aim of this preliminary work was to understand how leniency policies, by strengthening the moral hazard problem among firms, can enhance the breakdown of cartel activity in a framework with asymmetric information between the antitrust authority and the private sector.

The adoption of a leniency program is able to make law enforcement more effective by eliciting information from low cost sectors able to mimic an higher cost sector.

A mere reduction of sanctions has no effect on deterrence. Nevertheless, even if a program is not effective ex-ante, it can still works as safe-conduct to exit from ex-post not profitable cartels and avoid subsequent conviction by the authority.

This opportunity weakens further the deterrent potential of leniency and calls the authority for a thoughtful implementation of the program. To prevent the prospect of an amnesty from encouraging collusion, the scheme must be tailored to the characteristics of each particular authority.

The main innovation brought by this work is to consider the country-specific abilities of any authority and its legal framework in setting up an effective leniency program.

The effectiveness of investigative tools available to the authority influences the appealing of the program to potential cartelist and is of primary importance to design an effective program.

Thus, the authority should assess the peculiarities of its working environment to set up its program optimally, rather than adopting best practices shaped in other legislative frameworks.

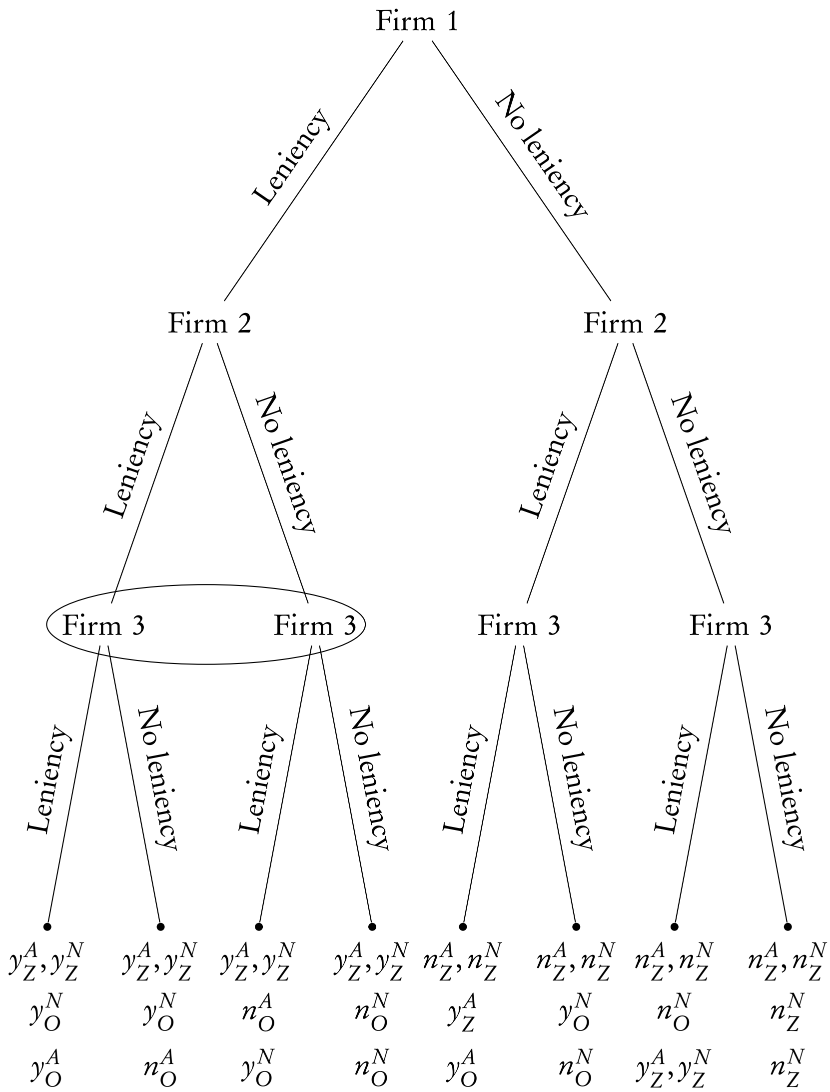

Figure 2: Two-stage game when $\gamma > \underline{\gamma}$ with $l = 2$, $n = 3$.

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Finito di stampare nel mese di Ottobre 2010
Presso **studiografico&stampadigitale Copy Right**
Via Torre Tonda 8 – Tel. 079.200395 – Fax 079.4360444
07100 Sassari

www.crenos.it

ISBN 978-88-84-67-610-8

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