The Optimal Enforcement of Antitrust Law

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SUMMARY

This paper analyses the optimal enforcement of competition policy against collusion under asymmetric information on cartel's costs and observable prices. The implementable price schedules are increasing, and the net profits decreasing, in cartel's costs, while expected penalties are increasing in observed prices. Hence, more efficient cartels enjoy positive (informational) rents. The optimal price schedule is higher than marginal costs even when enforcement is costless: since penalties can be at best zero, informational rents for more efficient types must be created through price-cost margins. This allocative distortion is lower for more efficient types, while full collusion can be tolerated for high cost cartels. Costly enforcement tends to reduce this distortion for less efficient types. Comparing antitrust enforcement with regulation, we find that regulation with positive transfers is better than antitrust enforcement, which however allows to implement more efficient outcomes than regulations without transfers.

NON TECHNICAL SUMMARY

Competition Policy is today one of the main tools of supply side public intervention, and developed according to similar approaches in all the industrialised countries. A recognised virtue of competition policy is found in the purpose of setting some general rules of behaviour, which distinguish what is prohibited from the wide range of conducts that can be freely chosen by firms with no further public interference. Hence, it is often argued that competition policy is less discretionary and intrusive than the traditional industrial policies, requiring only one-off interventions and no permanent monitoring of firms.

When we consider the enforcement of antitrust law, however, we find that no clear normative benchmark is set on the way in which fines should be graduated and the intensity of intervention should be focused. Nor is it well established whether an antitrust authority should apply the principles of the law or should design its intervention taking into account the likely reaction of firms.

We study the optimal enforcement of antitrust law against collusion when the antitrust authority does not observe firms marginal cost; in this case, the first best (price equal marginal cost) cannot be implemented for each type, and the enforcer must design the expected penalty schedule in order to induce cartels to set the lowest price compatible with asymmetric information. Collusion cannot be completely banned since a high price might be due to collusion or to high costs. The optimal policy entails no prosecution for low prices even if they are indirectly a signal of partial collusion. Creating (informative) rents for more efficient cartels at prices below the monopoly level is the only way to refrain them from setting their monopoly price. Expected penalties are increasing in the observed price and net profits decrease in cartel's costs, with the least efficient type eventually breaking even.

The price schedules implemented are less efficient than the outcome that can be obtained if a monopolist is regulated through positive transfers; however, if the regulator cannot use transfers and therefore adopts a sort of price cap, antitrust enforcement performs better.

CONTENTS

1 Introduction

Competition policy is today one of the building blocks of supply side public intervention in the economy in all the industrialized countries. The US has a centennial tradition since the adoption of the Sherman Act in 1890, and has developed so far a rich and changing body of laws and decisions in all the main areas of intervention. Competition policy has had a central role in European policy and in the creation of a unified European market since the Treaty of Rome in 1958, and today national antitrust laws have been adopted in all the EU countries; their harmonization with the principles of the Treaty of Rome on the issues of competition policy is almost complete.

In the redesign of supply side public intervention, competition policy tends to gain a major role, and eventually to replace the more traditional and discretionary tools of industrial policy based of transfers and subsidies to specific industries or firms. In this perspective, a recognized virtue of antitrust intervention is found in the purpose of setting some general rules of behaviour which distinguish what is prohibited from the wide range of conducts that can be freely chosen by firms with no further public interference. Hence, it is often argued that competition policy is less discretionary and intrusive than traditional industrial policies, requiring only one-off interventions and no permanent monitoring of firms.

This very loose description of antitrust law, however, leaves many open questions once we consider how to enforce competition policy. A first set of issues is related to identifying the conducts which should be considered illegal. Empirical observations across countries suggest that not all the conducts which can create allocative distortions are prosecuted by law: once collusion is excluded, an antitrust authority has nothing to say whether firms compete in quantities or prices, or adopt more complex market strategies aimed at relaxing price competition, even if these latter often imply less efficient outcomes. Dominant positions, at least in the European tradition, do not justify an intervention while their creation through mergers is severely controlled; the rationale for this approach, distinguishing internal growth on the merits from monopolization through external growth, offers only a very loose criterion which hardly justifies so different rules and precedures. Evaluating in a unified framework competion policy at work makes it very difficult to understand the reasons behind the specific approaches that have been prevailing in different areas of intervention, whether they summarize a workable way of dealing with asymmetric information, which is the role of a more conventional judicial approach to the subject, etc.

Once identified the set of illegal conducts, we have still several questions related to the enforcement of their prosecution. Among them: should an enforcer prosecute in the same way every kind of illegal behaviour? Which is the desirable degree (probability) of intervention and how can we direct it to the more relevant issues? How can we set the fines and damages that a party found guilty has to pay? Is ex ante general monitoring an essential part of the enforcement? Should we simply apply the principles of the law with no concern of private parties reactions, or should we try to anticipate how they will adjust to the policy implemented, inducing certain actions instead of others? Is the antitrust authority an active player of market interaction, or an external referee which enters in the field once the faul has been committed? And, consequently, is the antitrust authority a sort of social planner[1] or a more tolerant and loose controller? (how tolerant, how loose?)

This tentative list of issues suggests that we lack a clear normative benchmark to evaluate antitrust intervention and enforcement, finding it difficult to select how and according to what a desirable (optimal?) policy should be designed.

The problem is even more evident when we compare competition policy and regulation, a second central piece of modern intervention on the supply side. In the last decade regulation have been reconsidered and the literature has shown a clear drift from ad hoc regulatory schemes to the design of second best optimal mechanisms under asymmetric information[2]. Today we are used to consider regulation as a mechanism design problem where the authority chooses regulatory schemes in order to maximize welfare given a set of constraints, arising form asymmetric information, which summarize and anticipate how the regulated firm will react to the proposed mechanisms. Normative analysis can be performed, and optimal policies can be identified and compared. No such task can be pursued in competition policy analysis. Hence, we don't know how enforcement should be shaped and which are the likely outcomes we can expect when using this type of intervention.

This different status of the two policies is striking, for instance, when we analyze industry reform projects: privatization of the public utilities is today considered firstly as a problem of industry reform[3], and the distinction of the vertical segments which are natural monopoly from those where competition

[1]For a dissenting opinion on this point see Phlips (1995), p.12.

[2]See, for a review of the literature, Baron (1989), Laffont and Tirole (1993) and Laffont (1994).

[3]See for instance Amstrong et al (1995).

can be promoted has led in many cases to create a much more articulated industry structure. But, once designed the new industry structure, we have to choose the more appropriate public policies in the new situation. Where should we adopt a regulatory approach and where competition policy is preferable? How can we compare these two ways of intervention?

This paper aims at setting some initial block in this direction, focussing on the optimal enforcement of antitrust law. Although our analisys is normative in nature, we restrict our attention to the optimal design of antitrust intervention, this latter being positively identified by the typical practices that we observe in industrialized countries. We identify competition policy instruments with the fines that can be imposed if firms are proved to be guilty, while an antitrust authority has no power to prescribe explicitly the price or any other specific conduct which is potentially legal. In other words, the way in which we identify an antitrust intervention is positive, while the analysis of its optimal design is normative.

Our work is closely related to Besanko and Spulberg (1989), where the authors analyse the optimal design of antitrust intervention under asymmetric information when there are two types of cartels (costs). The enforcer commits to a set of instruments, i.e. fines and probability of intervention, which make the expected penalties contingent on some observed signal, as for instance the market price. They find that in a separating equilibrium the efficient cartel colludes and is not prosecuted, while the high cost cartel is induced to competitive (Bertrand [4]) behaviour and monitored with positive probability.

We generalize the Besanko and Spulberg (1989) model to a continuum of cartel types (costs) which are not observed either ex ante or ex post by the enforcer. This case is not simply a trivial extension: as the literature on crime and punishment has recently shown[5], the continuum of types case requires to consider much more seriously the problem of marginal deterrence. Since the enforcer cannot distinguish cartel types, she has to design the optimal expected penalty schedule in order to induce each type to select a particular price. We find that the price schedule implementable is increasing, while the net profits are decreasing in cartel's costs. Consequently, efficient cartels have positive informational rents according to the incentive compatible mechanisms. Moreover, the expected penalty schedule must be

[4]In a recent paper Baniak and Phlips (1996) extend the Besanko and Spulberg analysis to the case in which the non cooperative equilibrium is Cournot .

[5]See Mookherjee and Png (1996).

increasing if a price lower than the monopoly level is implemented. Since the most favourable penalty can be at most zero, the rents for efficient types must be created through price cost margins. The optimal price schedule, in fact, entails prices higher than costs for all the types, with larger allocative distortions for less efficient types, which can eventually implement full collusion and pay (in expected terms) the associated maximum penalty. This striking difference with the two types case previously studied is entirely due to marginal deterrence, and occurs even when prosecution is costless.

The paper is organized as follows. In section 2 we briefly summarize the main findings of the literature on crime and punishment, which offers the background of our analysis and suggests interesting insights for further research. Section 3 presents a model of antitrust intervention, while the optimal enforcement mechanism is discussed in section 4. In section 5 we compare the allocations implementable with different regulatory regimes and those with antitrust enforcement. Some comments on the advantages and limits of this approach for competition policy analysis conclude the paper.

2 The optimal enforcement of law

Since the seminal paper by Becker (1968) a growing stream of the Law and Economics literature has addressed the problem of analyzing with the tools of economics the choice of individuals regarding illegal and criminal behaviour and the design of enforcement policies able to prevent it. Our aim here is simply to offer a background useful for the modeling of antitrust enforcement and not to provide a complete review of this very wide literature. Therefore in this section we focus on the logical framework of this approach, summarizing some of the recent findings.

Optimal deterrence applies to individual actions which produce undesirable external effects on other parties. An agent can take an action a receiving benefits $tb(a)$ and imposing a harm $h(a)$ to some other individual. Individuals are heterogeneous in their private benefits from action a, with the term $t \in [0, T]$ describing the different types and $g(t)$ their distribution. A type t individual would select his preferred action $\hat{a}_t = arg\max_a tb(a)$, which in general is different from the social optimum $a_t^* = arg\max_a tb(a) - h(a)$. In order to influence private behaviour and reduce or eliminate the gap between $\hat{a}_t$ and a_t^* we can use the design and enforcement of law[6].

[6]In very general terms, the problem arises because the property rights of individuals are

A legal mechanism is described as a pair of schedules $s(a) \in [0, \bar{s}]$ and $f(a) \in [0, 1]$ referred respectively to the sanction and the probability of intervention as functions of the observed action a. If enforcement were costless and the authority would observe individual types, the ultimate effect would be that of inducing each individual t to take his socially desired action a_t^*. No intervention would be required for those types that are benevolent by nature, i.e. those who select $\hat{a}_t = a_t^*$, and for those actions $\tilde{a}$ which do not cause any relevant external effect, i.e. $h(\tilde{a}) = 0$.

This ideal situation, however, does not consider two fundamental elements of the picture. First of all, enforcement occurs under asymmetric information: the legal authority does not observe at least individual preferences as types, benefits and harms [7].

Secondly, law enforcement, requiring specific resources, is costly. If the sanction is a monetary fine, it is simply a transfer and does not cause any further welfare effect[8]. The probability of intervention, on the contrary, is related to the amount of resources involved in enforcement, a higher probability implying a higher cost. Hence, costly enforcement and informational asymmetries make the problem more complex and the outcome implementable presumably a second best one.

This set up can be applied to single or multiple actions, as, respectively, a murder or driving a car at different speed. The results, however, come out to be quite different in the single or multiple actions cases. In the former, the well known result by Becker (1968) prescribes maximal sanction $\bar{s}$ and the lowest probability consistent with deterrence for any undesirable action. When actions can be taken at different levels of harm, however, the problem of marginal deterrence becomes crucial: the expected penalty $s(a') \cdot f(a')$ designed to prevent action a' might have the undesirable effect of shifting the party to actions more harmful than a'. In other words, when an individual can take an action at different degrees of harm and/or different actions, the optimal deterrence policy must evaluate the overall plan of actions of the individual and must graduate the expected penalties in order to influence his choices in a direction which is globally desirable.

Marginal deterrence requires[9] to set marginal expected penalties every-

not well defined, preventing the emergence of a Coasian solution to the problem of externality.

[7] Assuming that types t are not observed is usually sufficient to capture the effects of asymmetric information in enforcement.

[8] Non monetary transfers or inprisonment would create a difference between private costs and social benefits, with a net welfare effect. We focus here on monetary fines, which are more appropriate to the antitrust case considered later on.

[9] The results quoted are taken from Mookherjee and Png (1994), who analyse the problem

where less than marginal harms[10] and to set a threshold under which no enforcement is provided[11].

It is worth noting that this approach models optimal deterrence of actions/types which cause significant external effects as a problem of inducing a desirable schedule of actions taking into account the asymmetric information of the enforcer. The analysis, in other words, is shaped as a mechanism design problem: when it is worth intervening, the policy should take into account the reaction of individuals to the policy itself, inducing the less harmful actions among those implementable.

3 A model of antitrust intervention

We develop now a model of antitrust intervention in order to highlight the features of optimal enforcement. Our explicit reference will be the intervention against collusive agreements, but an extension to anticompetitive practices of a dominant firm can be done using a similar framework. In both cases, infact, the law identifies some prohibited conduct and intervenes ex-post when there is evidence of violation. Merger policy instead has a different nature, being typically an ex-ante intervention that can prevent private firms from implementing a project simply by denying the authorization. Hence, the framework developed here cannot be directly referred to merger policy.

Since in a cartel a group of firms act coordinately and promote an agreed and illegal strategy, those firms will be treated as a single entity, the cartel, which is the party prosecuted by the enforcer.

Firms offer identical products and industry demand is described by a continuous, finite, downward sloping and concave demand function $D(p)$, with $D' < 0$, $D'' \leq 0$ and $D(p) = 0$ for $p \geq \overline{p}$. Costs are assumed to be perfectly correlated across firms, with $C_i = c \cdot q_i$. The marginal cost c is

in a very general framework.

[10]Intuitively, equating marginal penalties and marginal harms is not optimal since by slightly decreasing penalties we have second order effects on gross welfare but first order effects on enforcement costs, with an increase in net welfare.

[11]Reducing the penalties for less harmful actions marginally shifts individuals from more serious to less dangerous acts, reducing the cost of deterring greater harms. Notice that the reason for not prosecuting minor harm is not because the marginal harm falls short of the marginal benefit, an argument correct in the single action framework. Even with a net marginal harm, minor actions can be legalized if this helps to deter more harmful actions, a statement consistent with the multiaction marginal deterrence problem.

drawn from a support $[\underline{c}, \overline{c}]$ according to a continuous distribution $g(c)$. The firms know their own marginal cost c.

We assume that non cooperative behaviour is Bertrand, with $p = c$ and zero profits for every firm; moreover we assume that the conditions for a tacit collusive agreement at the highest (monopoly) price are satisfied, for instance in terms of a sufficiently high discount factor. The action chosen by the cartel is assumed to be simply a price $p \in [0, \overline{p}]$. Hence, the gross profits of the cartel with costs c are

$$u_c(p) = (p - c)D(p) \tag{1}$$

which, given the assumptions on $D(p)$, is differentiable, finite, concave and strictly decreasing in c. Let p_c^m be the associated monopoly price which maximizes $u_c(p)$.

Consumers surplus in the industry is given by

$$CS(p) = \int_p^{\overline{p}} D(s)ds \tag{2}$$

The enforcer does not observe the realization of the marginal cost c but knows the distribution $g(c)$ and the demand function $D(p)$, and (ex-post) observes the price p. More precisely, we assume that firms' costs are not observable either ex-ante or ex-post, through auditing. What the enforcer can eventually find when prosecuting a cartel is evidence of collusion, as for instance minutes of meetings, internal regulations that prescribe rules of reciprocal disclosure of information, etc.[12].

The enforcement mechanism is described by a pair of functions $s(p) \in [0, \overline{s}]$ and $f(p) \in [0, 1]$ which represent respectively the fine and the probability of being fined. This latter can be related to different contingencies, as the probability of being discovered, the probability of being prosecuted and the probability of being found guilty. We do not distinguish so far among these different stages of the enforcement policy, leaving to future research this task. The expected penalty associated to a price p is therefore $es(p) = f(p) \cdot s(p) \in [0, \overline{s}]$. The costs of the enforcement policy are linear in the probability of intervention, i.e. $C_e = k \cdot f(p)$.

The net profits of the cartel given the enforcement mechanism are

[12]We feel this assumption is quite close to actual antitrust enforcement, where proving collusion through an estimate of costs and monopoly price is usually not the case, while evidence of concerted practices is often the key argument for condemning.

$$\Pi_c(p) = u_c(p) - es(p) \tag{3}$$

All parties are assumed to be risk neutral. The enforcer is assumed to be benevolent and maximizes the sum of the surplus of the parties less the enforcement costs

$$E\,W(p) = \int_{\underline{c}}^{\bar{c}} [CS(p) + es(p) + \Pi_c(p) - kf(p)]\, g(c)dc \tag{4}$$

We can now derive the optimal enforcement mechanism.

4 The optimal enforcement of antitrust law

Since we assumed that collusion is always viable while non cooperative behaviour yields zero profits, the only constraint to setting the monopoly price is given by the possibility of being fined. Hence, the cartel will maximize profits by setting a price that is optimal given the expected penalty. Let

$$p_c = arg\max_p \Pi_c(p) = u_c(p) - es(p) \tag{5}$$

p_c defines the incentive compatible price schedule given the enforcement mechanism. The optimal mechanism will maximize the expected welfare (4) given the incentive compatibility constraint (5) and the participation constraint that no firm is forced to exit by competition policy, i.e.

$$\Pi_c(p_c) = u_c(p_c) - es(p_c) \geq 0 \quad \forall c \in [\underline{c}, \bar{c}] \tag{6}$$

Solving the problem in that way is rather cumbersome. Hence, we proceed according to Baron and Myerson (1982) by first identifying the implementable allocations that satisfy the two sets of constraints, and then by maximising the welfare function given the implementable allocations.

4.1 Implementable allocations

In this section we analyse the restrictions implied by the incentive compatible and participation constraints of the original problem that can help to meake it simpler. It is useful as an introductory step to see why the first best cannot be implemented even when penalties are extremely high, if the enforcer does not observe cartels' costs. Suppose that the maximum, very high, penalty $\bar{s}$ is used aiming at implementing $p_c = c$ for each type: since the participation

constraint must be met, it is not possible to prosecute any price lower than $\bar{c}$. Setting the highest penalty for prices higher than $\bar{c}$ induces bunching at $p = \bar{c}$ for all the types with $p_c^m \geq \bar{c}$, and a lower (monopoly) price for the more efficient types. The first best is therefore not achieved.

We restrict ourselves to implementing a piecewise continuous price schedule [13] A first step is proved in the following lemma, using a revealed preferences argument.

Lemma 1 *The incentive compatible schedule p_c is non decreasing in c.*

Proof: Let $c_1 < c_2$ be two levels of the marginal cost. From the definition of p_c it follows that

$$(p_{c_1} - c_1)D(p_{c_1}) - es(p_{c_1}) \geq (p_{c_2} - c_1)D(p_{c_2}) - es(p_{c_2})$$

and

$$(p_{c_2} - c_2)D(p_{c_2}) - es(p_{c_2}) \geq (p_{c_1} - c_2)D(p_{c_1}) - es(p_{c_1})$$

adding up and rearranging we obtain

$$(c_2 - c_1)(D(p_{c_1}) - D(p_{c_2})) \geq 0$$

which implies that $p_{c_1} \leq p_{c_2}$ □

Hence, an implementable price schedule cannot induce a lower price for a less efficient firm. The next step allows to characterize the net profits of a type c firm according to the incentive compatible price schedule. Let

$$\Pi_c(p_c) = u_c(p_c) - es(p_c)$$

be the net profits of a firm with cost c selecting its incentive compatible price p_c.

Lemma 2 *$\Pi_c(p_c)$ is decreasing in c*

[13] In the optimal control problem that will be explicitly considered when solving for the optimal mechanism, this restriction amounts to the standard assumption that the control - the implementable price - is piecewise continuous.

Proof: Differentiating $\Pi_c(p_c)$ by c we obtain

$$\frac{d\Pi_c(p_c)}{dc} = -D(p_c) + \left(\frac{du_c(p_c)}{dp} - \frac{des(p_c)}{dp} \right) \frac{dp_c}{dc} = -D(p_c) \qquad (7)$$

since the term in brackets is null due to the envelope theorem. □

Notice that condition (7) holds whether the expected penalty in increasing or constant at p_c, since in this latter case cartel c's optimal choice is identified by $du_c/dp = 0$ and the term in brackets vanishes as well.

If the enforcer were informed about the cartel costs c (and enforcement were costless), the optimal solution would be to induce through a sufficiently high sanction each firm to set $p = c$, the first best solution, and firms of any type would obtain no profit. In an asymmetric information and costly prosecution environment, the more efficient firms gain positive profits, which are to be interpreted as rents for their informational advantage.

Using the results in Lemma 1 and 2, we can further characterize the incentive compatible expected penalty.

Lemma 3 *If $p_c < p_c^m$, $es(p_c)$ is increasing at p_c.*

Proof: Suppose $p_c < p_c^m$. Then $u_c(p_c) < u_c(p)$ for some $p > p_c$. From the definition of p_c we know that $u_c(p) - es(p) \leq u_c(p_c) - es(p_c)$. Adding up the two inequalities and rearranging we obtain $es(p_c) < es(p)$ for some $p > p_c$. □

We can summarize the features of the implementable allocations in the following way. The enforcer has to prevent the cartel from setting a high (monopoly) price through expected penalties. The incentive compatible price schedule on which the policy is built must be non decreasing in costs, allowing less efficient firms to recover higher costs through higher prices. In order to prevent a general upward movement of prices, however, expected penalties must be sufficiently increasing in price to prevent a more efficient cartel from setting its monopoly price by mimicking a higher cost one. The overall effect is a fall in net profits as costs increase. More efficient cartels enjoy a positive rent due to their informational advantage, while less efficient ones might break even. We can now move to the analysis of optimal allocations among the implementable ones.

4.2 Optimal enforcement

Let's consider first expected penalties for the most efficient type. We have shown that, if deterrence occurs for some prices (costs), it requires an expected penalty schedule increasing in the observed price. Define $p_{\underline{c}} < p_{\underline{c}}^m$ as the lowest price implementable. A corollary of Lemma 3 is that, since no deterrence is needed for prices lower than $p_{\underline{c}}$, being the gross profits $u_c(p)$ increasing, the expected penalty can be flat for $p \leq p_{\underline{c}}$. What is needed to ensure marginal deterrence is that the expected penalty is increasing to the right at $p_{\underline{c}}$.

Since expected penalties are costly in terms of welfare, it is optimal to set $es(p) = 0$ for $p \leq p_{\underline{c}}$, with eventually[14] a kink at $p_{\underline{c}}$. Using this fact we can further characterize the expected penalities.

First of all, integrating (7) over $[c, \bar{c}]$ we obtain:

$$\int_c^{\bar{c}} \frac{d\Pi_c(p_c)}{dc}\, dc = -\int_c^{\bar{c}} D(p_c)dc$$

which, once solved, gives

$$\Pi_c(p_c) = \Pi_{\bar{c}}(p_{\bar{c}}) + \int_c^{\bar{c}} D(p_c)dc \tag{8}$$

Notice that, using the fact that $es(p_{\underline{c}}) = 0$, the incentive compatible profits of the highest and lowest types are related by the following expression:

$$\Pi_{\bar{c}}(p_{\bar{c}}) = u_{\underline{c}}(p_{\underline{c}}) - \int_{\underline{c}}^{c} D(p_c)dc \tag{9}$$

Finally, using (8) and solving for the expected penalties of a type c cartel we obtain

$$es(p_c) = u_c(p_c) - \Pi_{\bar{c}}(p_{\bar{c}}) - \int_c^{\bar{c}} D(p_c)dc \tag{10}$$

In order to ensure that $p_{\bar{c}}$ is the optimal price for a type $\bar{c}$ cartel, we must ensure that the expected penalties for prices higher than $p_{\bar{c}}$ are able to prevent the cartel from setting a higher (the monopoly) price. Since the highest gross profits are obtained at $p_{\bar{c}}^m$, in order to implement $p_{\bar{c}}$, expected penalites must be such that $\Pi_{\bar{c}}(p_{\bar{c}}^m) \leq \Pi_{\bar{c}}(p_{\bar{c}})$, which will hold as an equality at the lowest price schedule implementable. Using (9) and taking into account that the maximum expected penalty is $\bar{s}$, we obtain, after rearranging:

[14] More precisely, a kink will occur if $p_{\underline{c}} < p_{\underline{c}}^m$.

$$\bar{s} \geq es(p_{\bar{c}}^m) = u_{\bar{c}}(p_{\bar{c}}^m) - u_{\underline{c}}(p_{\underline{c}}) + \int_{\underline{c}}^{\bar{c}} D(p_c)dc \tag{11}$$

which sets a constraint on the lowest price schedule implementable. It is evident from the expression above that if the enforcer wants to implement a lower price schedule, which decreases $u_{\underline{c}}(p_{\underline{c}})$ and increases $D(p_c)$, a higher expected penalty schedule is required. Since a maximum penalty $\bar{s}$ is allowed, the enforcer is implicitly constrained on the set of implementable price schedules. Moreover, since expected penalties are increasing in observed prices and incentive compatible profits are decreasing in costs, we have to carefully check the participation constraint at the top.

The profits of the highest type when deviating to the monopoly price cannot be reduced below $u_{\bar{c}}(p_{\bar{c}}^m) - \bar{s}$. Hence, the participation constraint at the top becomes

$$\Pi_{\bar{c}}(p_{\bar{c}}) \geq \max\{0, u_{\bar{c}}(p_{\bar{c}}^m) - \bar{s}\} \tag{12}$$

Summing up, if $\bar{s} \geq u_{\bar{c}}(p_{\bar{c}}^m)$ the participation constraint binds at the top with the highest type cartel breaking even; moreover, the informational rents of the most efficient cartel are minimized by implementing the lowest price schedule. If the maximum penalty is lower than the gross monopoly profits of the least efficient cartel, even this latter will have some rents and the implementable price schedules will be higher.

Let's now consider the selection of the implementable allocation which maximizes welfare given the participation and incentive compatibility constraints and the boundary conditions on the expected penalties. This can be framed as an optimal control problem in which the state variable is the net profit $\Pi_c(p_c)$ and the control variable is the price $p_c \in [c, p_{\bar{c}}^m]$. We have seen that the set of participation constraints can be replaced by the condition (12), which means that we have a boundary condition on the state variable at the top. Incentive compatibility requires that (7), which is the state equation in our problem, holds. Moreover, it is well known from the literature on regulation[15] that, when the cost function is linear in output, the condition that the price schedule is nondecreasing in c is sufficient for incentive compatibility. Finally, we have to add the two constraints that the maximum expected penalty is not greater than the maximum penalty allowed

[15]See for instance, Baron (1989), p.1369 for a proof.

and that the minimum expected penalty is non negative. The first constraint is already encompassed by the participation constraint (12), while the requirement of non negative penalties will bind for the most efficient cartel, being the expected penalty increasing in the observed price.

The problem for the enforcer is therefore

$$\begin{aligned}
\max_{p_c} EW(p) \quad = \quad & \int_{\underline{c}}^{\bar{c}} [CS(p_c) + es(p_c) + \Pi_c(p_c) - (k/\bar{s})es(p_c)]\, g(c)dc \\
s.t. \quad & \\
& \frac{d\Pi_c}{dc} = -D(p_c) \\
& \Pi_{\bar{c}}(p_{\bar{c}}) \geq \max\{0, u_{\bar{c}}(p_{\bar{c}}^m) - \bar{s}\} \\
& u_{\underline{c}}(p_{\underline{c}}) - \Pi_{\bar{c}}(p_{\bar{c}}) - \int_{\underline{c}}^{\bar{c}} D(p_c)dc \geq 0 \\
& p_c \in [c, p_c^m]
\end{aligned}$$

and p_c being nondecreasing. Notice that we have set the penalty at the maximum level in order to minimize the costs of enforcement. We will proceed as usual by solving a relaxed problem in which the condition that the price schedule is nondecreasing is ignored, checking once solved that this requirement is met. Substituting (10) for $es(p_c)$ and integrating by parts we obtain:

$$\begin{aligned}
EW(p) \quad = \quad & \int_{\underline{c}}^{\bar{c}} [CS(p_c) + u_c(p_c) - (G(c)/g(c))D(p_c) + \Pi_c(p_c) \\
& -\Pi_{\bar{c}}(p_{\bar{c}}) - (k/\bar{s})es(p_c)]\, g(c)dc
\end{aligned}$$

Being $\Pi_{\bar{c}}(p_{\bar{c}})$ welfare decreasing, the participation constraint will bind at the top. The Hamiltonian of our problem is therefore:

$$\begin{aligned}
H \quad = \quad & \{CS(p_c) + (1 - k/\bar{s})\,[u_c(p_c) - D(p_c)G(c)/g(c) - max(0, u_{\bar{c}}(p_c^m) - \bar{s})] \\
& +\Pi_c(p_c)\}\, g(c) - \lambda(c)D(p_c) + \mu(u_{\underline{c}}(p_{\underline{c}}) - \int_{\underline{c}}^{\bar{c}} D(p_c)dc \\
& -max(0, u_{\bar{c}}(p_c^m) - \bar{s})) + \gamma(c)(p_c^m - p_c)
\end{aligned}$$

We initially consider the optimal enforcement when prosecution is costless, i.e. $k = 0$, or alternatively, when the cost of enforcement is fixed. This

preliminary result will make it clear that the cost of enforcement is only a part of the problem, and that even when prosecution can be increased with no constraint, asymmetric information plays a major role in the solution.

Proposition 4 *Suppose the prosecution costs k be zero and the maximum penalty be very high ($\bar{s} \geq u_{\bar{c}}(p_{\bar{c}})$). The optimal price schedule implementable is*

$$p_c = \min \left\{ c + \frac{g(\underline{c})}{g(c)} \frac{\int_{\underline{c}}^{\bar{c}} D(p_c)dc}{D(p_{\underline{c}})}, p_c^m \right\} \tag{13}$$

Proof: Notice that the Hamiltonian is concave in p_c as well as the constraint of non negative penalties. Hence, the solution of our optimal control problem solves the following equations:

$$\frac{\partial H}{\partial p_c} = \Big\{ (p_c - c - (G(c)/g(c))D'(p_c) + d\Pi_c/dp_c \Big\} - (\lambda(c)+\mu)D'(p_c) - \gamma(c) = 0 \tag{14}$$

$$\frac{d\lambda}{dc} = -\frac{\partial H}{\partial \Pi_c} = -g(c) \qquad \lambda(\underline{c}) = 0 \tag{15}$$

$$\frac{\partial H}{\partial \mu} = u_{\underline{c}}(p_{\underline{c}}) - \int_{\underline{c}}^{\bar{c}} D(p_c)dc = 0 \tag{16}$$

$$\frac{\partial H}{\partial \gamma(c)} = p_c^m \geq p_c \tag{17}$$

Integrating (15) we obtain $\lambda(c) = -F(c)$. Substituting in (14) and taking into account that $d\Pi_c/dp_c = 0$ for incentive compatibility, we obtain after rearranging

$$p_c = c + \frac{\mu}{g(c)} + \frac{\gamma(c)}{g(c)D'}$$

Substituting in (16) and guessing that $p_{\underline{c}} < p_{\underline{c}}^m$, i.e. $\gamma(\underline{c}) = 0$, we obtain:

$$\frac{\mu D(p_{\underline{c}})}{g(\underline{c})} = \int_{\underline{c}}^{\bar{c}} D(p_c)dc$$

Substituting in (14) and solving we obtain the expression of the price schedule, with $\gamma(c)$ adjusting for the price to be not greater than the monopoly

price; notice that the price schedule is nondecreasing in c, as required by incentive compatibility. Moreover, substituting the equilibrium price in the participation constraint for the highest cost type and in the non negative penalties constraint for the lowest cost type, it is easy to check that both are strictly binding. Finally, (14) for the lowest type would contain also the term $\mu du_{\underline{c}}/dp_{\underline{c}} > 0$, which would imply a different expression and a higher level of the welfare maximizing price, breaking the monotonicity constraint at the bottom. However, we are free to assign any value to the control at the points of discontinuity[16] without affecting the value of the Hamiltonian, being the distribution of c non atomic. Hence, we simply apply the expression above of the optimal price also to the lowest type. □

The result obtained requires some comments. We have seen that incentive compatibility requires to create rents for the more efficient types. If positive transfers are not allowed, as is the case when we can use only fines, informational rents must be created through price cost margins. Notice that the price schedule adds to the marginal cost c the mark-up $\mu/g(c)$: if the density distribution $g(c)$ is not increasing too much, it means that the allocative distortion is larger for less efficient types. For instance, with a uniform distribution of types, the additive mark-up is the same for all cartels, and therefore the price schedule is less distortionary for more efficient cartels. This is the outcome of two conflicting forces at work: on the one hand the traditional "no distortion at the top" principle; on the other hand the need to create sufficient incentives (rents) for efficient types to induce them to price below their monopoly price. When positive transfers are not allowed, it is not possible to separate the incentive and the allocative problem, reaching the first best. In our constrained problem of antitrust enforcement we cannot separate the two tasks, and therefore we are able to implement only a second best outcome.

Moreover, it must be noticed that transfering fines to consumers plays an important role in the welfare maximization problem: we allow less efficient firms to set prices closer to their monopoly level, but we fine them increasingly transferring the penalty to the consumers with no additional distortion. In some cases it is too optimistic to assume that this transfer can be implemented without distortion: for instance, we might not be able to identify the consumers which are active in the market involved, or there might be additional costs for the firm, as lost reputation, with no associated

[16]See for instance Seiertad and Sydsaeter (1987), p.73.

transfer to the consumers. But the simpler case in which fines are not pure transfers is when the enforcement is costly.

Hence, we now consider the optimal enforcement policy with costly prosecution, maintaining the assumption of maximum penalties sufficiently high.

Proposition 5 *The optimal enforcement policy with costly prosecution and* $\bar{s} \geq u_{\hat{c}}(p_{\hat{c}})$ *implements the price schedule identified by the following expression*[17]*:*

$$-D(p_c) + \frac{\partial u_c}{\partial p} - (\mu/g(c))D'(p_c) - \frac{k}{\bar{s}}\left[\frac{\partial u_c}{\partial p} - \frac{G(c)}{g(c)}D'(p_c)\right] - \gamma(c) = 0 \tag{18}$$

The result above can be easily proved on the same line of argument of the previous proposition. Consider the different terms of the expression. The first two terms correspond to the gross welfare variation when the price is increased, i.e. the variation in consumer surplus and gross profits. In the first best allocation they would balance out.

The other terms take into account the enforcement problem and constraints: $-D'\mu/g(c)$ is positive and determines the creation of price cost margins and increasing allocative distortions for less efficient types, as we have seen in the case of costless enforcement. The last term in brackets is related to enforcement costs, which add to the other terms in balancing marginal benefits and costs in terms of welfare [18]. Since this negative term in absolute terms becomes larger, through $G(c)$, as c increases, the incentive to increase price over costs is reduced for less efficient types, balancing the previous effect of an (almost) fixed additive mark up μ. This conclusion is in line with our intuition: if penalties are distortionary, allowing high prices for inefficient types and using fines to transfer welfare to consumers is inefficient, and we prefer to limit the increase in price cost margins for less efficient types.

[17] We assume $k/\bar{s}$ to be sufficiently small to ensure that the second order conditions hold.

[18] This term can be rewritten as $(\partial u_c/\partial p)g(c) - G(c)D'$. If the enforcer allows type $\hat{c}$ to set a higher price, she has to raise the prosecution rate applied to type $\hat{c}$ by $du_{\hat{c}}/dp$ in order to deter higher types from switching to that higher price. Since the frequency of type $\hat{c}$ is $g(\hat{c})$, this explains the first term. On the other hand, if $p_{\hat{c}}$ is higher, it becomes realively more attractive for cartel types $c < \hat{c}$, and the enforcer must increase expected penalties by $D'(p_{\hat{c}})$ on $c < \hat{c}$ without affecting marginal deterrence. Since $G(\hat{c})$ is the mass of those types, the second term is explained.

5 Antitrust vs regulation

We pointed out that often the design of supply side policy intervention has to choose between competition policy and regulation. The framework we have developed to analyse antitrust enforcement allows quite naturally to compare the outcomes implementable through competition policy with those obtainable through regulation. This latter encompasses obviously a very broad set of policies, which differ in terms of instruments and market structure; hence we do not pretend to perform a complete analysis of the issue. However, it seems interesting to compare, in terms of welfare, optimal antitrust enforcement with two regulatory regimes: when the regulator can use transfers to firms and when transfers are banned.

More precisely, consider the following policy regimes, all characterized by asymmetric information of the public authority on the costs of the firm(s).

AE : optimal enforcment of antitrust law through fines, with no cost of prosecution ($k = 0$) and sufficiently high maximum penalty ($\bar{s} \geq u_{\bar{c}}(p_{\bar{c}})$)

RT : regulation through a menu of contracts which specify a price $p(\hat{c})$ and a transfer $T(\hat{c})$ as a function of the reported costs $\hat{c}$.

RNT : regulation through a menu of contracts which specify a price $p(\hat{c})$ as a function of the reported costs $\hat{c}$.

AE corresponds to the optimal enforcement policy with costless prosecution analysed above. RT is referred to the Baron and Myerson (1982) model of regulation of a monopolist with unknown costs and RNT is the case in which the regulator cannot use transfers to the regulated firm. The following proposition establishes the ranking in terms of welfare among the three regimes.

Proposition 6 $EW_{RT} > EW_{AE} > EW_{RNT}$

Proof: We'll show that the three regimes can be expressed as different versions of the same mechanism design problem we analysed in the previous sections. The key point is the equivalence between direct mechanisms, those usually considered in the regulatory problem, and indirect mechanisms we used in the enforcement problem. Moreover, the assumption of perfectly correlated costs within the cartel makes the monopoly and oligopoly industrial structures perfectly comparable.

Compare first AE and RT. If we do not impose the constraint of non negative penalties in the enforcement problem analysed in proposition 4, i.e. if we set $\mu = 0$, we obtain $p_c = c$, i.e. the first best allocation for all types. Substituting in the expected penalty equation we have:

$$es(p_c) = -\int_c^{\bar{c}} D(p_c)dc$$

implying a positive transfer for all cartel types except the highest $\bar{c}$, which breaks even. This result corresponds to the solution of the Baron and Myerson (1982) model of regulation of a monopolist with unknown costs. Since the AE regime corresponds to the RT problem with an additional constraint of non negative penalties (negative transfers) the expected welfare will be lower in this regime.

Compare now AE and RNT. In this latter case the regulator has no way to create rents through transfers, and therefore we expect allocative distorsions. Moreover, the participation constraint implies that no price below $\bar{c}$ can be imposed, since costs are unknown. Hence, the menu of contracts as a function of the reported cost $\hat{c}$ is $p(\hat{c} = p_{\hat{c}}^m$ for $c \in [\underline{c}, \tilde{c}]$ and $p(\hat{c} = \bar{c}$ for $c \in (\tilde{c}, \bar{c}]$, where $\tilde{c}$ is such that $p_{\tilde{c}}^m = \bar{c}$. This mechanism clearly induces truthtelling revelation and solves incentive compatibility. The participation constraint will bind for the less efficient type. This mechanism is equivalent, in terms of outcomes, to the following expected penalty schedule for an AE problem: $es(p_c) = 0$ for $p_c \leq \bar{c}$ and $es(p_c) = \bar{s}$ for $p_c > \bar{c}$. This penalty schedule, given that $\bar{s} \geq u_{\tilde{c}}(p_{\tilde{c}})$ will induce bunching at $\bar{c}$ for all the cartels less efficient that $\tilde{c}$. Since the RNT problem can be entirely formulated as an AE problem with no further constraint, and its allocation does not correspond to the AE outcome, RNT must be inferior with respect to AE. □

Proposition 6 shows that competition policy is inferior with respect to regulation when this latter can use transfers: in this case, in fact the regulator is able to completely separate the incentive and the allocative problem reaching the first best. However the antitrust approach seems preferable when regulation cannot use transfers, as in a price cap regime: negative transfers - penalties - allow in fact to use more powerful mechanisms and to implement more efficient outcomes. Figure 1 shows the allocations implemented in the three regimes.

Figure 1 about here

The RT regime (- - - line) implements the first best through transfers

(negative penalties); the AE regime leaves rents through price cost margins at a lower level for efficient types than the RNT regime, in which cartels up to the $\tilde{c}$ type choose their monopoly price.

6 Concluding remarks

In this paper we have analyzed the optimal enforcement of antitrust law, i.e. of a policy which aims at maximizing social welfare using fines without observing cartel's types. The main features of the optimal policy are:

- The policy implements second best allocations with price cost margins for all the cartel types; hence, prices higher than marginal cost are not necessarely prosecuted even if they are indirectly evidence of (partial) collusion.
- The price cost margins tend to be lower for more efficient types;
- The expected penalty is increasing in observed price;
- Efficient cartels obtain (informational) rents while the least efficient cartel (eventually) breaks even;
- The antitrust enforcement regime is inferior with respect to a regulatory regime when transfers to firms are allowed, but is preferable to the situation in which regulators cannot use transfers, as in the price cap case.

The key ingredient of our results is the need to take into account marginal deterrence when information is asymmetric: if cartel types were observable either ex ante or ex post, first best allocations would be implementable provided that sufficiently high fines were feasible. Under asymmetric information partecipation and incentive compatibility constraints severely limit the set of implementable price schedules, and positive rents must be created for more efficient types in order to prevent them from setting higher prices.

Our result offers a possible explanation to some of the typical practices of competition policy at work: we often observe that collusion is not always prosecuted in the same way, or that pricing policies which relax price competition and create price cost margins are tolerated even if socially inefficient. Our result suggests that this may be part of an optimal policy.

Comparing our results with those in Besanko and Spulberg (1989) and in Baniak and Phlips (1996), we obtain in the continuous type case allocative distortions which differ from the two types case considered so far: in particular, in any separating equilibrium with only low and high cost cartels those latter are induced to behave non cooperatively while the efficient type colludes. In our setting the more efficient cartels choose in many cases lower price cost margins, but still receive higher rents since the expected penalty is lower for them.

In this paper we have focussed our analysis to a particular feature that positively identifies antitrust policy and distinguishes it from regulation, i.e. the feasibility of negative transfers to firms[19]. When we consider competition policy in practice there are other features which seem relevant, and that might be considered in future research.

First of all, regulation tends to define the menu of contracts ex ante, while typically antitrust is in most cases an ex post intervention: we bypassed this problem by assuming that the enforcer is able to commit to a policy, for instance by issuing guidelines and by building a reputation over time[20]. The problem of commitment, however, is extremely serious in regulation as well, once this is considered in a dynamic setting.

Secondly, competition policy is used in oligopoly situations while regulation is mainly conceived for monopoly: in our setting we do not exploit this difference and the enforcer treats the cartel as a single entity. An interesting case would be to design prosecution against collusion in order to induce some of the participants to reveal evidence on illegal behaviour, reducing the cost of enforcement.

Thirdly, in a broader political economy perspective, the regulatory capture issue seems quite different in the two insitutional settings we are comparing: regulation is strictly tied to the firm regulated in a long run and stable relationship; on the contrary an antitrust authority is competent over a wide range of industries and no sistematic relationship tends to occur. Hence, firms' pressure in the initial phase when the policy is designed is much less likely in competition policy. However, if competition policy maintains a certain degree of ex post discretion with respect to regulation, the incentives to bribe ex post might be higher.

[19]In this sense the outcomes we obtain would be similar to those implementable by regulating a monopolist through taxes under asymmetric information.

[20]The no commitment case in antitrust enforcement is for instance considered in Martini and Rovesti (1997).

Finally, the recent literature on optimal deterrence offers many suggestions for future research in the field of antitrust enforcement. An interesting distinction has been proposed between general and specific enforcement (monitoring), the first being the case in which the intensity of intervention cannot a priori be conditioned to the specific action observed[21]. This is the case, for instance, of general ex ante monitoring (of markets), that can produce evidence of illegal behaviour of different nature and severity. In this case, in order to obtain an increasing expected penalty schedule, it is necessary to set fines increasing in the action observed. If, however, the intensity of intervention can be conditioned on the action, as for instance when more resources are involved in proving a more harmful accusation, increasing expected penalties can be obtained by raising the probability of being fined setting the sanction at the highest level[22].

References

[1] Amstrong M., Cowan S. Vickers J. (1994), *Regulatory Reform: Economic Analysis and British Experience*, Cambridge, MIT Press.

[2] Baniak A., Phlips L. (1996) Antitrust Enforcement with Asymmetric Information and Cournot Strategies, *mimeo*

[3] Baron D. (1989), Design of Regulatory Mechanisms and Institutions, in R.Schmalensee, R. Willig (eds.), *Handbook of Industrial Organization*, North Holland, vol. 2, pp.1347-1444

[4] Baron D., Myerson R. (1982), Regulating a Monopolist with Unknown Costs, *Econometrica*, 50:911-30.

[5] Baron D., Besanko D. (1984), Regulation, Asymmetric Information and Auditing, *Rand Journal of Economics*, 15:447-470.

[6] Becker G. (1968), Crime and Punishment: an Economic Approach, *Journal of Political Economy*, 76:169-217.

[7] Besanko, D. Spulber D. (1989), Antitrust Enforcement under Asymmetric Information, *The Economic Journal*, 99:408-25.

[21] See Shavell (1991).

[22] See Mookherjee and Png (1992).

[8] Loeb M., Magat W. (1979), A Decentralized Method for Utility Regulation, *Journal of Law and Economics*, 22:399-404.

[9] Martini G. Rovesti C. (1997), Welfare Effects of Antitrust Policy under Different Regimes: is Commitment Better than Discretion? *mimeo.*

[10] Mokherjee D., Png I. (1992), Monitoring vis-a-vis Investigation in Enforcement of Law, *American Economic Review*, 82:556-65.

[11] Mokherjee D., Png I. (1994), Marginal Deterrence in Enforcement of Law, *Journal of Political Economy*, 102:1039-1066.

[12] Phlips L. (1995), *Competition Policy: a Game Theoretic Approach*, Cambridge, Cambridge U.P.

[13] Seierstad A., Sydsaeter K. (1987), Optimal Control Theory with Economic Applications, North Holland

[14] Shavell S. (1991) Specific versus General Enforcement of Law, *Journal of Political Economy*, 99:1088-1108.

[15] Stigler G. (1970), The Optimum Enforcement of Laws, *Journal of Political Economy*, 78:526-36.

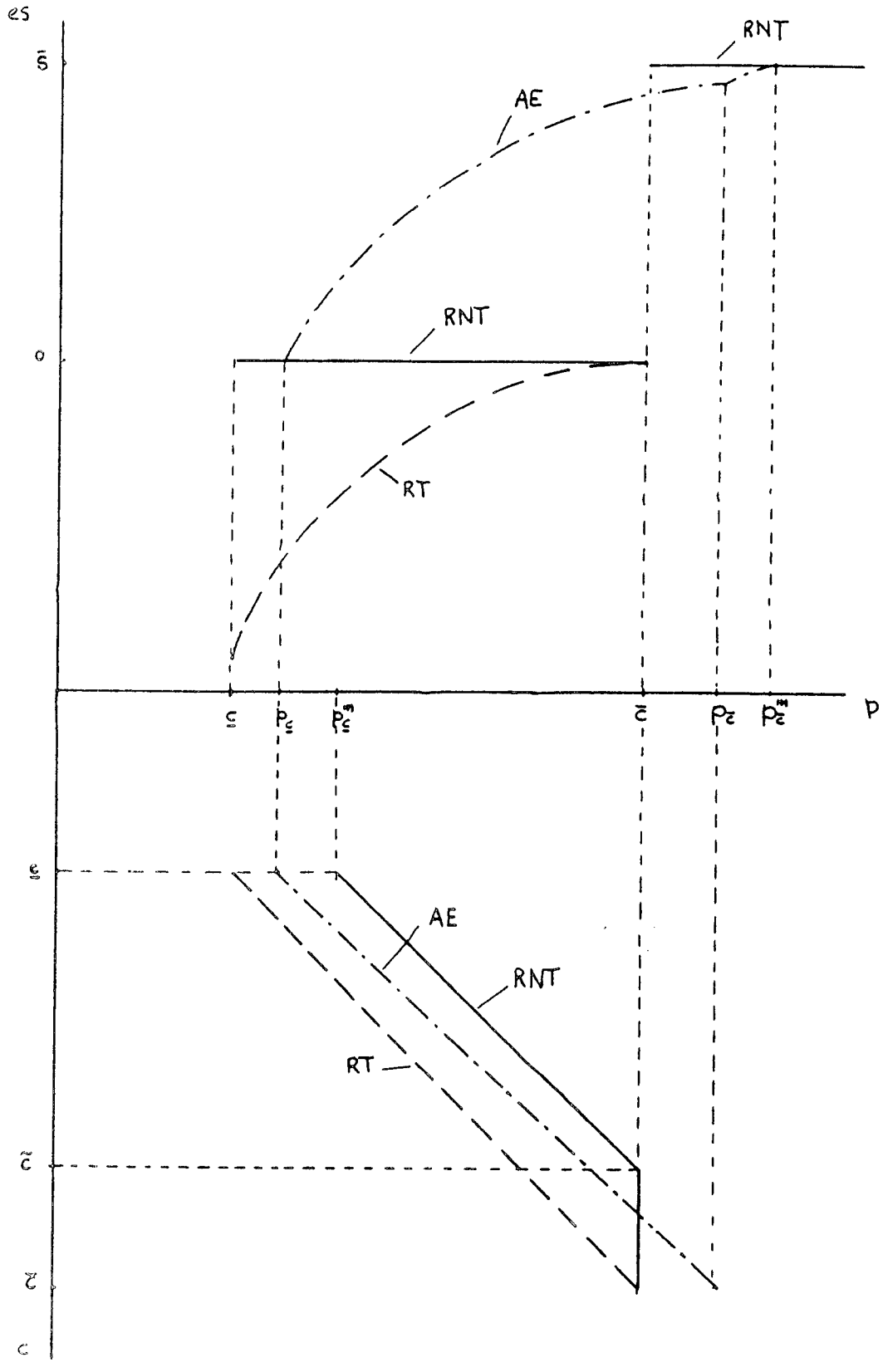

Figure 1: Expected penalties (transfers) and price allocations under different policy regimes: RT (Regulation with transfers), RNT (Regulation with no transfer) and AE (Antitrust enforcement)

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(xv) Paper presented at the Human Capital and Mobility Program "Designing Economic Policy for Management of Natural Resources and the Environment" Second Workshop FEEM, GRETA, University of Crete, Venice, May 12-13, 1995

(xvi) Paper presented at the International Workshop on "The Political Economy of Economic Policy - The Organization of Government" European Science Foundation and Fondazione Eni Enrico Mattei, Castelgandolfo (Rome), September 5-10, 1995

(xvii) This paper was presented at the Workshop on "Corporate Governance and Property Rights" organized by the Corporate Governance Network and by Fondazione Eni Enrico Mattei, Milan, 16-17 June 1995

(xviii) This paper was presented at the International Workshop on "Creation and Transfer of Knowledge: Institutions and Incentives" organized by the Fondazione Eni Enrico Mattei and the Beijer International Institute of Ecological Economics, Castelgandolfo (Rome), September 21-23, 1995

(xix) This paper was presented at the International Workshop on "Environment and Transport in Economic Modelling" organized by the Department of Economics - Ca' Foscari University, Venice for the "Progetto Finalizzato Trasporti 2" CNR and in cooperation with Fondazione Eni Enrico Mattei, Venice, November 9-10, 1995

(xx) This paper was presented at the Conference on "Technology, Employment and Labour Markets" organized by the Athens University of Economics and Business and Fondazione Eni Enrico Mattei, Athens, May 16-18, 1996

(xxi) This paper was presented at the Conference on "Applications of Environmental Accounting", sponsored by the Fondazione Eni Enrico Mattei and the State Science and Technology Commission of the People's Republic of China, Beijing China, March 11-13, 1996

(xxii) This paper was presented at the Conference on "Economics of Tourism", Fondazione Eni Enrico Mattei and University of Crete, Crete, October 13-14, 1995

(xxiii) This paper was presented at the Conference on "The Economics and Law of Voluntary Approaches in Environmental Policy", Fondazione Eni Enrico Mattei and CERNA (Ecole des Mines de Paris), Venice, November 18-19, 1996

(xxiv) This paper was presented at the Conference on "Pressure Groups, Self-Regulation and Enforcement Mechanisms", Fondazione Eni Enrico Mattei, Milan, January 10-11, 1997

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