Chapter 11
The Anticompetitive Effects of the Antitrust Policy

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Abstract Few scholars have seriously considered the possibility that the very existence of an antitrust law might make markets less competitive. In this chapter, we provide a selective review of this thought-provoking literature. The focus of our analysis is on contributions within the limits of the neo-classical theory of firms and markets, pointing out that antitrust legislation can hinder price/output competition. Following this literature, the introduction of antitrust penalties or leniency programmes can have the perverse effect of stabilizing cartels and increasing their size, as these policies may raise the costs of deviating and/or renegotiating a collusive agreement.

Introduction

Economists, legal scholars and historians have consistently alerted policy makers to the difficulty of establishing the anticompetive nature of cartels and other agreements among firms, to the welfare costs of "too-much" antitrust regulation and the risk of its misapplication. Since enforcing antitrust policies is costly, it might be optimal for society (consumers and producers) to tolerate some degree of collusion

[1] See Posner (1976), Bork (1978), Sproul (1993), Crandall and Winston (2003), and Levenstein and Suslow (2006). A broad, updated review of the economic theory of competition policy is provided by Motta (2004).

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among firms, while saving on investigation, prosecution and compliance costs and reducing the probability of erroneously acting against non-colluding firms (Besanko and Spulber 1989; Souam 2001; Frezal 2006; Martin 2006). However, few scholars have seriously considered the possibility that the very existence of an antitrust law might make markets less competitive, stimulating rather than deterring collusive practices. In this chapter, we provide a selective review of this thought-provoking literature.

Among those who have underlined the anticompetitive effects of laws prohibiting explicit collusive agreements we can distinguish two broad groups. The former consists of scholars in the libertarian, anarchy-capitalist tradition who totally reject the antitrust legislation as violating property rights, hindering free competition and damaging people's individual interests. They typically argue that as long as access to the market is free, we cannot speak of monopoly, even for goods and services currently served by only one producer. Similarly, to the extent that agreements of any sort are voluntarily subscribed by individuals, and consumers are not coerced by force to acquire a certain product, we cannot speak of conspiracy against competition. As Murray Rothbard, the undisputed champion in the libertarian tradition, strikingly claimed: "The only viable definition of monopoly is a grant [or privilege] from the government. It is therefore quite clear that it is impossible for the government to *decrease* monopoly by passing punitive laws."(Rothbard 1970, p. 60).[2] In this view, cartels are simply a form of organization alternative to markets that, like firms in the Coase's celebrated *Nature of firms* (Coase 1937), allows better coordination of decisions and effort among cartel members, reducing transaction costs and creating value for members and others (Rothbard 1962; Salin 1996).

A second group of contributions moves within the limits of the neo-classical theory of firms and markets, pointing out that antitrust legislation can hinder price/output competition. Following this literature, the introduction of antitrust penalties or leniency programmes can have the perverse effect of stabilizing cartels and increasing their size, as these policies may raise the costs of deviating and/or renegotiating a collusive agreement (McCutcheon 1997; Ellis and Wilson 2001; Harrington 2004; Bartolini and Zazzaro 2008).

In this chapter, we focus exclusively on the latter strand of literature, restricting our attention to models of static competition. The rest of the chapter is organized as follows: in the next section, we consider the effects of antitrust penalties on competition; then, we extend the analysis to leniency programmes and draw some concluding remarks.

[2] The absolute irreconcilability between free capitalism and antitrust legislation in the libertarian tradition is well summarized by Walter Block: "The premise underlying laissez-faire capitalism is that the only actions which should be illegal are those which involve an initiation of aggression against another person or his property. Antitrust law is clearly in violation of this principle, because it prohibits business practices no one even alleges constitute such depredations." (Block 1994, p. 35).

Antitrust policy I: Monetary Fines

The need for a public authority to combat practices restrictive of competition is unanimously claimed by the economic literature on static competition. Absent innovation, collusive agreements among firms for restricting output or increasing prices reduce consumer surplus and social welfare, as they reduce the number of rival sellers in the market. Economists classify collusive behavior in two types: *tacit*, when firms coordinate without communicating with each other; *explicit*, when firms communicate to reach an agreement. Antitrust authorities, however, can prosecute collusive agreements only in the presence of hard evidence of conduct violating competition laws. This makes collusion very difficult to detect and combat. The main instrument at the disposal of authorities to inhibit cartel formation is monetary fines, levied against firms found guilty of collusion in front of a court of law.

In this section we show that fines do not always hit their target, and in some circumstances they can even favor collusion. Specifically, we discuss four recent contributions that highlight the possibility that the introduction of an antitrust monetary fine adversely affects competition by making collusive agreements tougher to break up. These contributions differ in the modeling approach and in the stage of the cartel's life they focus on. The first two papers consider the case of tacit collusion sustained through price strategies; the third contribution considers explicit collusion where sustainability is threatened by the possibility to renegotiate the collusive agreement; the fourth focuses on the process of cartel formation, rather than on its sustainability, which is warranted by the assumption of binding agreements.

Antitrust Fines and the Cost of Deviating

Ever since Stigler (1950), industrial economists have recognized that cartels are characterized by a fundamental instability due to the incentives each member has to deviate from the collusive agreement by increasing output or reducing prices. Therefore, in order to sustain a collusive cartel, firms need to devise a strategy to *punish* deviations from the agreement. For instance, coalition members could agree to decrease (increase) prices (output) so as to eliminate possible gains from deviation. The implementation of this punishment strategy, however, involves a sudden change in either prices or quantities, which can be seen as a signal of collusion by the antitrust authority. This would raise the probability of members being fined, and increase the cost of cheating on the collusive agreement.

Cyrenne (1999)

The signaling effect of the punishment phase was first investigated by Cyrenne (1999) who considered a non-cooperative model of collusion with uncertain demand based on Green and Porter (1984). In this model, collusive behavior is sustained

through a finite reversion trigger strategy, where firms punish a deviation by supplying the Cournot–Nash quantity for $T-1$ periods, and then revert to the collusive quantity. Firms, however, do not directly observe deviations; they only observe a "common market price," p_t, which depends on the industry output Q_t, and a zero-mean-value stochastic part θ:

$$p_t = p(Q_t) + \theta_t \tag{11.1}$$

Therefore, when a firm observes a market price lower than the reference price $p(Q_t)$, it does not know whether such a price is the result of a deviation from collusion (an increase in Q_t) or an adverse demand shock (a decrease in θ_t). In this context, firms engage in punishment only if the price goes below a certain threshold, p^*, which represents the rule of punishment firms agreed upon, that is, only if $\theta < p^* - p(Q_t)$. The probability that this event happens is $\gamma = G(p^* - p(Q_t))$ where $G(\cdot)$ is the distribution function of θ. Whenever a trigger strategy is initiated, firms are placed under investigation by the antitrust authority and bear a penalty F, which can be thought of as the fine times the probability of being convicted of collusion, plus the costs of mounting a defence.

The expected discounted value of producing the collusive output q is given by the current profit, plus the expected profits for the next periods which vary with probability γ, the trigger strategy adopted, and the antitrust penalty:

$$\begin{aligned} V_i(q) &= \pi_i(q) + (1-\gamma)\,\delta V_i(q) + \gamma\left(\sum_{\tau=1}^{T-1}\delta^\tau \pi^n + \delta^T V_i(q) - F\right) \\ &= \frac{\pi^n}{1-\delta} + \frac{\pi_i(q) - \pi^n - \gamma F}{1-\delta+\gamma(\delta-\delta^T)} \end{aligned} \tag{11.2}$$

where $\delta > 0$ is the discount factor and π^n indicates the Nash profits from the punishment strategy.

When deciding on the level of p^* and the length of punishment $(T-1)$, firms must balance the need to sustain the cartel with the risk of starting a price war, simply because a demand shock has occurred. Green and Porter show that the output chosen collusively by firms exceeds the joint profit maximizing output, because firms prefer to reduce gains from a deviation, so as to reduce the severity of the punishment. When collusion is considered illegal, firms are also aware that any deviation may trigger an antitrust investigation and a penalty F. As a result, the equilibrium collusive output is still lower (and market less competitive), as "the gains from deviating from the collusive strategy have been reduced exogenously" by the introduction of the antitrust fine (Cyrenne 1999, p. 265).

Harrington (2004)

The anticompetitive result in Cyrenne's model is based on the assumption that the output strategy of competitors is unobservable and the probability of being audited does not actually depend on the magnitude of price variation. Harrington (2004),

provides a richer analysis of cartel pricing behavior that considers the whole pricing path. Contrary to Cyrenne, in Harrington's model the pricing strategy of the other firms is observable, hence each firm can immediately detect deviation from the collusive price tacitly agreed upon. Firms, of course, would prefer to collude on high prices, but in doing so they face two types of constraints: internal stability and antitrust auditing policy. The former concerns the incentive of deviating from the collusive agreement: the higher the collusive price, the greater the incentive to break up the cartel. The latter refers to the risk of attracting the attention of the antitrust authority, for the probability of auditing increases with the variation in the level of prices.

Harrington compares the steady-state collusive price when collusion is legal with the steady-state price in the presence of an antitrust law and demonstrates that in some cases the introduction of an antitrust penalty might increase the long-run collusive price. In particular, a price p sustains collusion if:

$$\frac{\pi(p)}{1-\delta} \geq \bar{\pi}(\psi(p), p) + \delta\left(\frac{\pi^n}{1-\delta}\right) \tag{11.3}$$

where the left hand side represents the discounted flow of collusive profits,[3] which must be higher than the deviation payoff $\bar{\pi}$, plus the discounted payoff from punishment π^n – which is the profit firms earn when they play the Nash equilibrium strategy.[4] Denote by $\tilde{p}$ the highest price which supports collusion. If condition (11.3) holds for all $p \in [p^n, p^m]$, where p^m is the monopolistic price, then $\tilde{p} = p^m$; otherwise $\tilde{p}$ is the price that makes firms indifferent between colluding and cheating, i.e., the price for which condition (11.3) holds as equality.

In the presence of an antitrust authority, colluding firms have to consider the probability of being investigated and convicted by a court to pay a penalty. Harrington assumes this probability to be exogenous and dependent on the observed variation of prices between the current and the previous period:

$$\phi(p^t, p^{t-1})$$

The function $\phi(\cdot,\cdot)$ assumes a value of zero when $p^t = p^{t-1}$, and is weakly increasing with respect to price increments. The penalty in the case of successful prosecution is characterized by a fixed fine F.[5] Let $\bar{\Lambda}(p)$ be the maximum payoff

[3] The collusive profit does not necessarily derive from monopoly pricing; it depends on the price level firms in the cartel decide to enforce.

[4] The function $\psi(p)$ defines the deviating price which maximizes the firm's profit given that all the other firms' price is p.

[5] In the original model, Harrington (2004) assumes that the penalty also consists of a compensative part X^t, proportional to the social welfare losses produced by collusion, which increase with the current collusive price and the duration of the cartel.

of deviation from the collusive price p:

$$\bar{\Lambda}(p) = \arg\max_{p_i} \bar{\pi}(p_i, p) + \delta\phi(p_i, p)\left(\frac{\pi^n}{1-\delta} - F\right) + \delta[1-\phi(p_i, p)]\left(\frac{\pi^n}{1-\delta}\right) \tag{11.4}$$

and p^* be the highest price sustaining collusion in the presence of antitrust penalty, which is defined by:

$$\frac{\pi(p)}{1-\delta} \lessgtr \bar{\Lambda}(p) \text{ as } p \gtrless p^* \qquad \forall\, p \in [p^n,\, p^m] \tag{11.5}$$

In words, p^* is the price that makes firms indifferent between continuing to collude and deviating. The question is whether p^* is greater than $\tilde{p}$. In order to prove that the collusive price under antitrust legislation can be higher than the collusive price without antitrust, Harrington shows that the payoff of cheating is greater in the absence of antitrust penalties, that is

$$\bar{\pi}(\psi(p), p) + \delta\left(\frac{\pi^n}{1-\delta}\right) > \bar{\pi}(p_i, p) + \delta\phi(p_i, p)\left(\frac{\pi^n}{1-\delta} - F\right) + \delta[1-\phi(p_i, p)]\left(\frac{\pi^n}{1-\delta}\right) \tag{11.6}$$

Considering that $\bar{\pi}(\psi(p), p) \geq \bar{\pi}(p_i, p)$ for all p, condition (11.6) becomes:

$$\frac{\pi^n}{1-\delta} > \phi(p_i, p)\left(\frac{\pi^n}{1-\delta} - F\right) + [1-\phi(p_i, p)]\left(\frac{\pi^n}{1-\delta}\right) \tag{11.7}$$

and, after some computation, we have:

$$\frac{\pi^n}{1-\delta} > \frac{\pi^n}{1-\delta} - \phi(p_i, p)F \tag{11.8}$$

which is satisfied, as $F > 0$.

Therefore, the antitrust penalty reduces the gains from deviation. As a consequence, we have:

$$\frac{\pi(\tilde{p})}{1-\delta} \geq \bar{\Lambda}(\tilde{p}) \tag{11.9}$$

From condition (11.5), this implies that $\tilde{p} \leq p^*$. Now we have two possible cases: either $\tilde{p} = p^m$, and therefore the antitrust fine cannot produce any perverse effect, or $\tilde{p} < p^m$ and the collusive price in the presence of an antitrust fine is higher than the collusive price without such a policy.[6]

[6] The result that the antitrust penalty reduces competition only when the original price is lower than the monopolistic price, is mirrored by a similar condition in Bartolini and Zazzaro (2008), where in order to have the perverse effect the market structure without antitrust should not be a monopolistic cartel. We postpone further discussion on this point after the introduction of Bartolini and Zazzaro's model.

Antitrust Fines and Cartel Formation

In both Cyrenne's and Harrington's models the perverse effect of the antitrust fine is the result of the relaxation of the internal stability constraint. The intuition is that by decreasing the gains from deviation, the antitrust policy may lead to a higher (lower) collusive price (output). While focusing on the effect of the antitrust penalty upon the strategy which sustains collusion, both models only consider the case of tacit collusion and leave unexplored firms' incentives to sign explicit collusive agreements.

In this section we focus on the formation of cartels. Two theoretical models are considered: the first one is in line with the traditional non-cooperative approach, while the second one applies a cooperative approach to cartel formation.

McCutcheon (1997)

When we consider the formation of an explicit cartel, the collusive agreement should specify, besides prices and output, a punishment strategy to deter cartel members' deviations from the agreement. In this setting, cartels are sustained as an equilibrium of a repeated game under the implicit assumption that the punishment strategy is credible, and that the cartel's members can commit to it. However, this cannot be taken for granted, as typically the punishment strategy damages not only the deviators, but also the members that enforce the punishment. Therefore, cartel members might be willing to renegotiate the initial agreement once a firm deviates. The point is that when firms form a cartel or renegotiate their rules they need to meet to set the details of the agreement. These meetings are likely to leave some evidence, which the antitrust authority can exploit in order to prove the existence of the collusive agreement in front of a court of law.

McCutcheon (1997) considers a setting in which firms need to meet, at least once, to set up the collusive agreement, and, then, they *may* meet again for renegotiating the terms of the original agreement. She shows that in a standard Bertrand duopoly model with homogeneous products, the possibility of renegotiaing the original agreement and the costs of renegotiation affect the equilibrium outcome and the effectiveness of an antitrust fine.

In a repeated game version of this model, absent renegotiation, a collusive monopolistic price can be sustained by a trigger strategy whenever:

$$\frac{\pi^m}{2(1-\delta)} \geq \pi^m + \frac{\delta}{1-\delta}\pi^n \tag{11.10}$$

where $\delta > 0$ is the discount factor, while π^m and π^n indicate as usual the profits from monopolistic collusion and the profit arising from playing the Nash equilibrium at any stage after deviation.

Now, let us assume that renegotiation is possible and *costless*. A collusive agreement would hardly be sustained in this scenario. For instance, in the above example

firms would have an incentive to meet with the deviating firm and renegotiate another collusive agreement, the reason being that by punishing the deviating firm they also punish themselves. If this is so, the punishment strategy is not credible and the cartel cannot be sustained. This opens the quest for punishment mechanisms that are renegotiation-proof, i.e., punishment strategies whose payoffs are not Pareto-inferior to other available alternatives. McCutcheon, however, shows that in a repeated game where the stage game is a Bertrand duopoly with pure strategies, the only renegotiation-proof equilibrium is the one-shot Nash equilibrium of the game. Hence, if renegotiation is costless, firms cannot collude.

Although there might be other oligopoly games and renegotiation procedures which do not destroy the possibility of forming cartels, the message is that renegotiation is bad for collusion and good for competition. Now, if an antitrust penalty is introduced, firms have to compare the cost of renegotiating the agreement, in terms of the expected fine, with the benefits of doing so. Suppose that in every meeting the cartel incurs a probability $\theta \in [0, 1]$ of being detected and being punished with a monetary fine f. Therefore the expected cost of each meeting is $F = \theta f$. The benefit of such meetings is the discounted value of collusive profits net of the profits earned when a collusive agreement (or renegotiation) is not achieved. Therefore, in the initial meeting, where the decision to form a cartel is taken, these gains are equal to:

$$\frac{\pi^m}{2(1-\delta)} - \frac{\pi^n}{1-\delta} \tag{11.11}$$

If, for simplicity, we normalize the Nash equilibrium profit to zero, the first meeting would not take place, and the cartel would not form, if:

$$F \geq \overline{F} = \frac{\pi^m}{2(1-\delta)} \tag{11.12}$$

In the following meetings, where the original agreement may be renegotiated, the net gains depend on the punishment strategy. For example, with a trigger strategy the benefits are the same as for the initial meeting, implying no possibility either to form or sustain the collusive agreement. Specifically, when $F \geq \overline{F}$, no meeting takes place, while when $F < \overline{F}$ renegotiation is always profitable and therefore collusion is not sustainable.

When the punishment phase lasts for a given number of periods T, say the minimum number of punishment periods that satisfy internal stability, the benefit from renegotiation will be lower than the benefit from the first agreement

$$\tilde{F} = \frac{\pi^m}{2}\left(\frac{1-\delta^T}{1-\delta}\right) < \overline{F} \tag{11.13}$$

and a renegotiation meeting will take place only if $F < \tilde{F}$. In this case, we have three cases:

1. The actual antitrust fine is low, that is $F < \tilde{F}$. Thus the expected cost of a meeting is low too and renegotiation will always take place, preventing the formation of a collusive cartel.
2. The antitrust fine is at an intermediate level, that is $\tilde{F} \leq F < \overline{F}$. Thus the expected cost is high enough to prevent renegotiation, but not so high to prevent the initial meeting, hence leading to a stable cartel.
3. The antitrust fine is large, that is $F \geq \overline{F}$. Thus the expected cost of the initial meeting is so high that no collusive agreement takes place.

Finally, it is worth noting that the "perverse" effect of the antitrust penalty depends on the discount factor. In particular, for a given punishment strategy of length T, the possibility of $F \in [\tilde{F}, \overline{F}]$ increases with δ: the more firms care about future payoffs the wider is the range of anticompetitive expected fines.

Bartolini and Zazzaro (2008)

Although the need for meeting qualifies McCutcheon's model as an explicit collusion model, once again the mechanism through which antitrust fines might reduce competition in the market is by providing sustainability of cartels of a given size. In Cyrenne (1999) and Harrington (2004) the existence of an antitrust penalty increases the cost of cheating on the implicit agreement, while in McCutcheon (1997) the presence of (not very large) antitrust fines increases the cost of renegotiating the punishment strategy, enhancing the sustainability of the cartel. However, a question left almost unanswered by the literature on collusion is the process of cartel formation. How many firms enter a cartel? What happens if more than one cartel forms?

In order to address these issues, a change in the methodological approach is needed. A natural candidate for this change is the theory of coalition formation, recently extended by Bloch (1996) and Ray and Vohra (1997, 1999) by considering a partition function approach with externalities.[7] This literature focuses on the formation of coalitions across a given number of players, and it is directly applicable to the case of collusion, providing a characterization of a generic industry into coalitions of firms (cartels).

Bartolini and Zazzaro (2008) build on this literature to consider the role of the antitrust penalty on cartel formation: they provide a general result showing that if the firms' payoff structure is characterized by grand coalition superadditivity (GCS) and coalitional symmetry (CS), and if the equilibrium structure of the industry, in the absence of the antitrust policy, is not a monopolistic cartel, then there exists a range of antitrust penalties which would lead to the formation of the monopolistic cartel (the grand coalition), reducing market competition.

Grand coalition superadditivity and coalitional symmetry are the basic ingredients of many cartel formation models. For GCS, industry profits reach their highest

[7] See Ray (2007) for an introduction to this literature.

level in the grand coalition.[8] CS requires that industry profits are equally shared among coalitions, regardless of the coalition structure (e.g., regardless of the number of members per coalition). It is worth noting that CS implies symmetric players, the absence of synergy among cartel members and the presence of positive externalities in cartel formation. Put together, GCS and CS are sufficient to show that there exists a range of values of the expected antitrust fine that break any partial cartel but do not deter the formation of the grand coalition.[9]

Formally, consider a symmetric game of coalition formation $\Gamma(N, \Omega, \pi)$, where N is a finite number of firms, Ω is the set of all possible partitions of these firms into cartels (coalitions), and π is the set of firms' payoff (partition function).[10] Define F as the expected antitrust penalty, which is equal to the monetary fine times the probability of being convicted. Let F_1 be the penalty level above which firms in the monopolistic cartel prefer to deviate to the singleton structure, where all firms compete individually, and, analogously, let $F_{\mathcal{P}}$ be the minimum antitrust penalty which breaks up a coalition structure $\mathcal{P} \in \Omega$. Then it can be proved that if π satisfies grand coalition superadditivity and coalitional symmetry, $F_1 \geq F_{\mathcal{P}}$ for all $\mathcal{P} \in \Omega$ (Bartolini and Zazzaro, 2008, Proposition 3).

In other words, in the class of games that are characterized by GCS and CS there always exists a range of penalties, F, such that all coalition structures but the grand coalition are broken up. Therefore, if the market structure in the absence of an antitrust law consists of more than one monopolistic cartel, it exists a level of antitrust penalty that would lead firms to form the grand coalition. The intuition is that as the antitrust penalty increases the cost of forming a cartel, it reduces the possibility of firms in the industry free riding on the decisions of others to restrict competition. Given the assumptions of GCS and CS, in any coalition structure $\mathcal{P}$ there is at least one cartel in which the *per-member* payoff is lower than in the grand coalition. As a consequence, any coalition structure $\mathcal{P}$ is destabilized by a smaller fine than the grand coalition. Obviously, as in McCutcheon (1997), if the expected penalty is set at a level higher than F_1, even the monopolistic cartel is unprofitable and no cartel forms in the industry.

To illustrate, consider the case of five symmetric firms with constant marginal cost c, competing *à la* Cournot in a market characterized by homogeneous goods and a linear inverse demand $p = a - bQ$.[11] Before competing, firms can decide whether to form a cartel. Once formed, cartels compete non-cooperatively in the

[8] GCS is a weaker version of superadditivity, as it only requires the firms' payoff vector in the grand coalition (the monopolistic cartel) to be larger than the payoff vector of firms in any other coalition structure. Formally, given N players, for every state $x = (\pi, \mathcal{P})$, there is $x' = (\pi', \{N\})$ such that $\pi' \geq \pi$, where $\{N\}$ is the grand coalition, $\mathcal{P}$ is any coalition structure, and π is the firms' payoff vector (Ray 2007, p. 192).

[9] Under stricter conditions, this result can be extended to the case of asymmetric firms (Bartolini and Zazzaro 2008).

[10] For a definition of coalition games, see Ray (2007).

[11] This example was first studied by Ray and Vohra (1997) and then revisited in Bartolini and Zazzaro (2008).

Table 11.1 Structure of the game $\Gamma(5, \Omega, \pi)$

coalition structure		π_1	π_2	π_3	π_4	π_5
$\mathcal{P}_1$	{1,2,3,4,5}	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{20}$
$\mathcal{P}_2$	{1,2,3,4} {5}	$\frac{1}{36}$	$\frac{1}{36}$	$\frac{1}{36}$	$\frac{1}{36}$	$\frac{1}{9}$
$\mathcal{P}_3$	{1,2,3} {4,5}	$\frac{1}{27}$	$\frac{1}{27}$	$\frac{1}{27}$	$\frac{1}{18}$	$\frac{1}{18}$
$\mathcal{P}_4$	{1,2,3} {4} {5}	$\frac{1}{48}$	$\frac{1}{48}$	$\frac{1}{48}$	$\frac{1}{16}$	$\frac{1}{16}$
$\mathcal{P}_5$	{1,2} {3,4} {5}	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{16}$
$\mathcal{P}_6$	{1,2} {3} {4} {5}	$\frac{1}{50}$	$\frac{1}{50}$	$\frac{1}{25}$	$\frac{1}{25}$	$\frac{1}{25}$
$\mathcal{P}^*$	{1} {2} {3} {4} {5}	$\frac{1}{36}$	$\frac{1}{36}$	$\frac{1}{36}$	$\frac{1}{36}$	$\frac{1}{36}$

Firms' payoffs are normalized by imposing $\frac{(a-c)^2}{b} = 1$

market. In this game, a coalition structure $\mathcal{P}$ consists of $m(\mathcal{P})$ cartels, S_j, of size s_j. The per-member payoff is given by

$$\pi_i(S_j, \mathcal{P}) = \frac{1}{s_j} \frac{(a-c)^2}{b[m(\mathcal{P})+1]^2} \qquad \forall\, i \in S_j, \quad \forall S_j \in \mathcal{P} \quad \text{and} \quad \forall\, \mathcal{P} \in \Omega \tag{11.14}$$

Since firms are symmetric, we assume that the profit generated by a coalition is equally shared among members.[12] The incentive which drives firms to form a cartel is clearly reducing $m(\mathcal{P})$, which increases the payoff of the cartel. However, as the number of participants in the cartel increases, s_j, the per-member profit decreases. Hence, each firm has an incentive to stay out of the cartel, hoping that the rest of the firms form a cartel. The structure of this game is summarized by Table 11.1,[13] where we impose $\frac{(a-c)^2}{b} = 1$.

The equilibrium (or equilibria) of the coalition game $\Gamma(5, \Omega, \pi)$ depends on the assumptions on how coalitions actually form. To be specific, we consider the concept of *equilibrium binding agreement* (EBA), introduced by Ray and Vohra (1997). A coalition structure $\mathcal{P}$ is an EBA if it is not *blocked* by any other finer coalition structure. Put differently, a coalition structure is stable only if firms have no incentive to deviate to another structure that can be formed via disintegration of existing coalitions. According to this concept, it is easy to show that the monopolistic cartel

[12] This is not a restriction as Ray and Vohra (1997) show that the equal division of the coalition worth arises in any equilibrium of a coalition formation game with symmetric players.

[13] Since players are symmetric, we can omit coalition structures that are just a permutation of players in the same coalition structure.

is not stable because firm 5 has an incentive not to sign a monopolistic collusive agreement, for its payoff in $\mathcal{P}_2$, is higher than in $\mathcal{P}_1$. The only EBA is the coalition structure $\mathcal{P}_5$, where two cartels form and one firm stays alone.[14] Here no firm has an incentive to split into finer coalitions, whether $\mathcal{P}_6$ or $\mathcal{P}^*$.[15]

Now, let us introduce a perturbation of the game Γ by an antitrust penalty F imposed on firms found guilty of restricting competition. Consider the coalition structure $\mathcal{P}_5$. If the penalty announced by the antitrust authority is sufficiently high to make the payoff of firms in cartels $\{1, 2\}$ and $\{3, 4\}$ lower than the payoff they can gain competing as singletons, i.e., if $F \geq F_5 = \left(\frac{1}{32} - \frac{1}{36}\right) = \frac{1}{288}$, then $\mathcal{P}_5$ is no longer sustainable as an EBA. If, however, $F < F_3 = \left(\frac{1}{27} - \frac{1}{36}\right) = \frac{1}{108}$ firms would find it optimal to partition themselves as in $\mathcal{P}_3$. In fact, firms in the two-member cartel receive a higher individual expected payoff than in the grand coalition, hence blocking $\mathcal{P}_1$; at the same time, firms in the three-member cartel have no incentive to split because in $\mathcal{P}_3$ they receive a profit higher than in $\mathcal{P}^*$. However, for firms in the three-member cartel the individual payoff is lower than in the grand coalition $\mathcal{P}_1$. This implies that if $\frac{1}{108} \leq F < F_1 = \left(\frac{1}{20} - \frac{1}{36}\right) = \frac{1}{45}$ the penalty would dissolve $\mathcal{P}_3$, but not the monopolistic cartel which, due to GCS, is still more rewarding than competition in $\mathcal{P}^*$.

Summing up, the effect of an increase in the expected fine on competition is *not* monotone; at first, we have a decrease in competition, and only when the fine hits the highest threshold is there an increase in competition. When the authority cannot observe the level of market demand (or firms' costs) and, hence, the threshold above which the penalty induces atomistic competition, it is possible that the (non-distortionary and socially costless) penalty which maximizes the social welfare is lower than F_1 and, in some circumstances, even zero.

Antitrust policy II: Leniency Programmes

In the previous section, we actually abstracted from the fact that the antitrust authority does not directly apply any penalty to firms, and that it is only a court of law that, after hearing the alleged colluders and the authority, and evaluating the bevidence, can impose and enforce a penalty. The main purpose of leniency programmes is precisely to reduce the costs of the auditing process and, more importantly, to facilitate the collection of legal evidence of collusion. This is achieved by granting a penalty reduction to firms which self-report the existence of a cartel and facilitate the collection of evidence.

[14] Actually the singleton coalition structure, $\mathcal{P}^*$, is always an EBA by definition; firms should not select this equilibrium, however, if there is another which gives all of them a higher payoff.

[15] Obviously, if we apply a different concept of stability the coalition structure prevailing in equilibrium can be different. For example, using the sequential formation model proposed by Bloch (1996), the equilibrium of the game is coalition structure $\mathcal{P}_2$, that still consists of a partial cartel, leaving unaltered the possibility of the antitrust penalty generating anticompetitive effects.

In the United States, the Department of Justice introduced the possibility to grant immunity from criminal sanctions to self-reporting firms in 1978.[16] The leniency programme was radically revised in 1993, providing for the "automatic" granting of (monetary and criminal) leniency to the first firm reporting the existence of a cartel, while it remains discretionary for the other firms. Moreover, the possibility of applying for leniency is granted even after an investigation process has begun. These features have contributed to the success of the "revised" leniency programme. According to data reported by the OECD (2002), on average, 20 companies per years have applied for leniency, with respect to one per year with the old programme. Since the US leniency programme was revised, cooperation from applicants resulted in a dramatic increase of convictions and in over USD 4 billion in criminal fines (Hammond, 2008). The European Commission introduced its first leniency programme in 1996 and revised it in 2002, increasing the size of the fine abatement and reducing the discretionality of its application.

Apart from helping the antitrust authority to detect cartels and gain information on price-fixing agreements, leniency programmes can also be designed so as to discourage the formation of cartels or encourage their breakdown. In particular, while the leniency granted *after* an investigation has started aims at facilitating the provision of evidence in the trial, the leniency granted to whistleblowers *before* their cartel is placed under scrutiny by the authority affects firms' incentives to enter a collusive agreement or break up the existing ones.

Leniency During Investigation

In this subsection, we consider the effect of leniency programmes when firms can apply (for leniency) even after an investigation has started.

Motta and Polo (2003)

The relationship between leniency programmes and antitrust law enforcement was first studied by Motta and Polo (2003), who pointed out that the effectiveness of the programme depends on the possibility of cartel members applying for leniency even after a formal investigation has started. To illustrate, assume that firms face an expected penalty from colluding equal to μF, where $\mu = \alpha\theta$ consists of two parts, the probability of being audited $\alpha \in [0, 1]$, and the probability of being convicted $\theta \in [0, 1]$. Assume also that the leniency programme reduces the monetary fine to reporting firms, $R < F$, but without rewarding them $R \geq 0$.

In this setting, Motta and Polo (2003) consider two possible scenarios. In the first scenario, firms can apply for leniency $only$ before the authority has begun

[16] In the US, unlike Europe, price fixing is a criminal offense.

an auditing process. In the second, self-reporting firms can apply for leniency *also* after an investigation has started. The time structure of the sequential game is the following:

- At date 0, the antitrust agency announces the policy, $\{\alpha,\ \theta,\ F,\ R\}$.
- At date 1, firms decide whether to collude or deviate, and the corresponding profits are realised.
- At date 2, firms decide whether to report and apply for leniency.
- At date 3, an investigation may take place, and according to the leniency programme firms can collaborate and apply for a reduction of the fine, or not.
- At date 4, (1) if cartels have been punished the Nash equilibrium is played; (2) if cartels have been investigated but not found guilty no further investigation can take place, finally; (3) if cartels have not been investigated the game is repeated from date 1 onwards.

As usual, let π^m be the profit in the case of collusion, π^d the profit from deviation, π^n the Nash equilibrium profit and δ the discount factor. The ex-ante payoff of firms at date 1 is given by the following equations,

$$V_{cnr} = \pi^m + \delta\left\{\alpha\left[\theta\left(\frac{\pi^n}{1-\delta} - F\right) + (1-\theta)\left(\frac{\pi^m}{1-\delta}\right)\right] + (1-\alpha)V_{cnr}\right\} \tag{11.15}$$

$$V_{cr} = \pi^m + \delta\left[\alpha\left(\frac{\pi^n}{1-\delta} - R\right) + (1-\alpha)V_{cr}\right] \tag{11.16}$$

$$V_r = \pi^m + \delta\left(\frac{\pi^n}{1-\delta} - R\right) \tag{11.17}$$

$$V_d = \pi^d + \frac{\delta}{1-\delta}\pi^n \tag{11.18}$$

Since all the subgame perfect equilibria involve symmetric strategies, these equations describe all possible sets of equilibrium strategies. V_{cnr} represents the present value of colluding at date 1 and then not applying for leniency either before or after an investigation has taken place. In this case, the cartel is sentenced to pay a fine F with probability $\alpha\theta$. V_{cr} is the present value of colluding at stage 1 and then applying for leniency if an investigation has started. In this case the probability of punishment has increased to α, but the penalty is lower, $R < F$. When the firm self-reports before being investigated, the payoff is V_r equal to the discounted flow of Nash equilibrium profits minus the reduced penalty R. Finally, the expected value from deviation is V_d, where a firm gets the deviation profit in the first period and the Nash equilibrium payoff subsequently.

When the leniency programme does not allow firms under investigation to apply for a reduced fine, V_{cr} cannot be an equilibrium strategy, as firms receive no benefit by reporting. As a consequence, since $V_r \leq V_d$ for any $R \geq 0$, the leniency policy has no effect on the collusive behaviour of firms. In this case, if the level of the expected penalty, F, is not high enough to deter the formation of a cartel, i.e., to make $V_{cnr} < V_d$, the introduction of a leniency programme does not affect the sustainability of the agreement, as no firm has an incentive to apply for leniency.

On the contrary, if the leniency programme allows firms report after the investigation has started, the programme might influence the collusion strategy by making V_{cr} greater than V_{cnr}. Therefore, even if firms find it optimal to form a cartel, $V_{cnr} > V_d$, once they are placed under scrutiny by the authority they might prefer to desist from colluding and apply for leniency. However, if at the outset $V_{cnr} < V_d$, the introduction of a very generous fine rebate for whistleblowers could have the perverse effect of favouring the formation of collusive agreements, because, while the antitrust fine would not be high enough to discourage firms from colluding, the possibility of being relieved of the penalty once the cartel is detected can make collusion profitable, $V_{cr} > V_d$.

Leniency (Only) before Investigation

We now consider leniency programmes in which the possibility to apply for leniency is allowed only before a firm is audited.

Ellis and Wilson (2001)

The idea that in order to be effective in deterring cartels, leniency has to be extended to firms under investigation is challenged by Ellis and Wilson (2001), who show that leniency may break up collusive agreements even when firms can apply for leniency only before any formal investigation has started. Their main argument is that the firm which applies for leniency not only avoids the fine, but may also gain in terms of market competition with respect to the other members of the cartel which are affected by the antitrust penalty. As they argue (Ellis and Wilson 2001, pp. 9–10), "the damage [to the other firms] might arise from the jailing of key executives, as well as the costs of rebuilding lost reputation. Furthermore, once convicted of antitrust abuses a firm is often made to introduce costly internal mechanisms that ensure future compliance with the antitrust laws."

Ellis and Wilson consider Bertrand competition among n firms producing differentiated products. In this set-up, the share of market captured by each firm depends on the cost structure of the other firms. The antitrust penalty works as an extra cost which forces firm to change their optimal strategy. As a result, the Nash equilibrium favors the firm which has applied for leniency, whose cost structure has not changed.

This intuition can be easily incorporated into Motta and Polo's model, by changing the expected value of reporting:

$$V_r' = \pi^m + \delta(\bar{\pi}^n - R) + \frac{\delta^2}{1-\delta}\pi^n \qquad \text{with } \bar{\pi}^n > \pi^n \tag{11.19}$$

In the first period, the firm gains the monopoly profit, π^m. In the second period, the firm reports, incurring a fine R but gaining $\bar{\pi}^n$ which is higher than the Nash Equilibrium profit without the fine. Then in the subsequent periods the usual Nash

equilibrium is played. Clearly, the gains from deviating may be smaller than the gains from reporting, $V_r' > V_d$. In particular, assuming $R = 0$, a necessary condition for the firm to report is:

$$\delta > \frac{\pi^d - \pi^m}{\bar{\pi}^n - \pi^n} \tag{11.20}$$

Ellis and Wilson (2001) push this argument even further, arguing that the leniency programme can actually reinforce the stability of the cartel. In the event that no firm self-reports the cartel, the sole presence of the leniency programme may act as a punishment mechanism that makes deviations less profitable and a cartel with a higher pricing strategy sustainable. The feasibility of this argument relies on the assumption that all firms but the deviant can actually apply and benefit from the leniency programme. In this situation the benefit from deviation becomes:

$$V_d' = \pi^d + \delta(\underline{\pi}^n - F) + \frac{\delta^2}{1-\delta}\pi^n \qquad \text{with } \underline{\pi}^n < \pi^n \tag{11.21}$$

In conclusion, leniency programmes make the punishment more bitter for the deviating firm, but also less costly for the firms that enforce it, and this can make collusive agreement stronger.

Spagnolo (2000)

Motta and Polo (2003) show that when leniency is also granted to firms reporting after an investigation has started, it can create a perverse incentive to form new cartels, as the punishment is actually reduced.

This argument is further pursued by Spagnolo (2000), who shows that even a leniency programme which does not allow applications to be filed when the cartel is under investigation, can adversely affect competition in the market. This is because it reduces the net benefit from deviation and, therefore, facilitates the formation of cartels.[17] Here, we present a simplified version of Spagnolo's model which captures the essential ingredients of his analysis:

- At date 0, the antitrust authority announces its policy $\{\alpha, F, R\}$, where we assume that $\theta = 1$, i.e., if audited, a firm is always fined.
- At date 1, firms decide whether to collude or deviate on prices.
- At date 2, firms observe the strategies played in the previous stage, and decide whether to report (and, if possible, apply for leniency R); buyers observe the prices and the sale takes place.
- At date 3, if no firm has reported in the previous stage, the investigation is started with probability α, and colluding firms must pay F.

[17] This perverse effect is also discussed by Buccirossi and Spagnolo (2006), who apply a similar framework to a model of illegal trade.

The punishment inflicted at date 3 consists of a monetary fine F, plus a damage equal to the profits made so far, so that, after a cartel is detected and colluders have paid back profits to the authority, their payoff is negative.

Notice that the structure of the game is essentially one-shot, as firms choose either prices or output[18] only once, at date 1. However, the game has some elements of sequentiality as the strategy of the firm consists in both setting the price (or quantity) and deciding whether to report the existence of the cartel.

In this setting, if no antitrust policy is in place, it is well known that collusion strategies cannot be supported as an equilibrium. Similarly, in the absence of a leniency programme, i.e., $R = F$, no collusive strategy can be sustained in equilibrium. Consider the case in which firms have an incentive to form a cartel, i.e., $(1-\alpha)\pi^m - \alpha F > \pi^n$. Firms could enforce this agreement by threatening to report, at date 2, the existence of the cartel if some firm deviates; this strategy, however, would enforce a collusive agreement only if credible. At date 2, a firm which observes a deviation by another firm can either go along with it or report the existence of the cartel, receiving the following payoffs,

$$\begin{aligned} V_{nr} &= (1-\alpha)\pi^{md} - \alpha F \quad \text{(if it does not report)} \\ V_r &= -F \quad \text{(if it does report)} \end{aligned}$$

where π^{md} is the payoff a firm that played the collusive strategy receives if some other firm deviates. Clearly, the strategy to report the cartel if somebody deviates is credible only if $V_{nr} < V_r$ and $\pi^{md} < -F$, which $never$ holds as long as $\pi^{md} \geq 0$. Therefore, the simple implementation of an antitrust penalty does not induce a collusive equilibrium.

Things change when the law provides for a partial or complete penalty exemption for firms that reveal the existence of the cartel to the Authority, i.e., $R \in [0, F)$. Firms now incur a different (lower) penalty if they report the cartel, so the punishment strategy is credible if

$$\begin{aligned} (1-\alpha)\pi^{md} - \alpha F &< -R \\ R &< \alpha F - (1-\alpha)\pi^{md} \end{aligned} \tag{11.22}$$

If $\pi^{md} \geq \frac{\alpha}{1-\alpha} F$, then a leniency programme that does not provide any reward to whistleblowers cannot affect the collusive agreement, and we are back to Motta and Polo's result. However, as long as $\pi^{md} < \frac{\alpha}{1-\alpha} F$ and the leniency programme consists in a large penalty rebate – small R – the antitrust policy provides the incentive to sustain collusive agreements, that were impossible had the leniency policy not been introduced. In particular, Spagnolo (2000) considers the case of competition à la Bertrand, where $\pi^n = \pi^{md} = 0$, and shows that a strong leniency programme, with $R = 0$, induces the formation of a cartel for any level of collusive prices, p^c, such that $(1-\alpha)\pi(p^c) - \alpha F \geq 0$.

[18] In Spagnolo's model only duopolistic Bertrand competition is considered.

It is worth noting that an increase in the monetary fine F or in the probability of auditing α, would increase *ex-ante* deterrence, but, making condition (11.22) easier to satisfy, would increase the sustainability of the cartel. However, as Spagnolo notes, the key ingredient of his model is the impossibility of the deviating firm to fine tune the negative effect of deviation on the other firms. Otherwise, a firm could choose a deviating strategy that makes firms indifferent between reporting and not reporting, hence making collusion always unsustainable.

Given the objective of our analysis, we conclude by drawing attention to a variation of Spagnolo's model that can provide further interesting insights in terms of perverse effects of antitrust monetary fines. In the sequential model proposed by Spagnolo (2000), firms' payoffs are realized only at the end of the game. In this way, a report of a collusive cartel would lead to the repetition of the entire game. This can be a natural set-up for the analysis of procurement auctions, where the whole procedure can be subject to annulment, even after the auction has taken place. However, it is a less realistic assumption when considering antitrust trials in which it is in practice very difficult to take the profits firms accumulated during the life span of the cartel away.[19] Accordingly, let us consider Spagnolo's model with an antitrust policy consisting only in the enforcement of a fixed fine F with probability α, i.e., colluding firms can retain their past profits if the cartel is detected. In this case, it is easy to show that even in the absence of a penalty discount, $R = F$, if the antitrust penalty is not very high, the threat to reveal the existence of the collusive agreement to the authority can be credible enhancing the sustainability of the cartel. Assume that the antitrust fine is not sufficiently high to deter firms from forming a cartel:

$$\begin{aligned} \pi^m - \alpha F &< \pi^n \\ F &< \frac{\pi^m - \pi^n}{\alpha} = F^* \end{aligned} \tag{11.23}$$

The strategy to punish deviators by reporting evidence on the collusive agreement is now credible if:

$$\begin{aligned} \pi^{md} - \alpha F &< \pi^n - F \\ F &< \frac{\pi^n - \pi^{md}}{1-\alpha} = \widetilde{F} \end{aligned} \tag{11.24}$$

When condition (11.24) holds, firms would find it more profitable to pay a fine rather than let somebody deviate and break up the cartel. Under Bertrand competition this condition in never satisfied, as $\pi^n = \pi^{md} = 0$ (consistent with Spagnolo's model). However, if we consider other types of competition, say Cournot competition, one cannot exclude that there exist some strategies for which $\pi^n > \pi^{md}$. In this case, if $F < \widetilde{F} < F^*$ the presence of an antitrust monetary fine makes the punishment strategy credible and, once more, it proves an unintentional device to sustain collusive cartels.

[19] In antitrust laws, however, it is common to introduce some elements of proportionality in penalty schemes.

Concluding Remarks

A common theme in the industrial organization literature is that in the in presence of market imperfections competition should be regulated and protected by law. However, the same market imperfections could cause antitrust interventions to be detrimental of market competition.

Although the models presented in this chapter span different methodological approaches, they all show that the introduction of antitrust fines and leniency programmes may have undesirable, anticompetitive effects.

As regards monetary fines, contributions in the standard framework of noncooperative repeated games Cyrenne (1999); Harrington (2004); McCutcheon (1997) demonstrate that a monetary fine tends to reduce competition by making the collusive agreement easier to sustain, because the fine increases the costs of deviation and/or the cost of renegotiating the original agreement. Bartolini and Zazzaro (2008) focus on the formation of cartels within the approach of coalition formation games. They show that a monetary fine, discouraging the formation of partial cartels, reduces the possibility of some firms exploiting the positive externality generated by collusive agreements and increases the incentives to form a monopolistic coalition.

Albeit using different approaches, these models reach similar conclusions. For instance, in both Bartolini and Zazzaro's and McCutcheon' s models, the perverse effect arises only for intermediate values of the monetary fine, while a "sufficiently" large penalty would prevent the formation of any cartel. Furthermore, Harrington's model predicts that the perverse effect does not arise should the cartel adopt a monopolistic price strategy. Analogously, Bartolini and Zazzaro's model predicts a perverse effect of the antitrust penalty only if firms are not colluding as a monopolistic cartel.

In the same vein, a generous leniency programme can break collusive agreements, as it makes the threat of self-reporting more credible. In general, leniency policies reduce the duration of collusive agreements, which is good for markets where a cartel would have formed anyway. We cannot exclude, however, the formation of cartels in industries where a cartel would not have formed had the leniency programme not been in place.

Finally, it is important to stress that the general message coming from this literature does not point to the abrupt elimination of any antitrust policy. Rather, it is a note of caution for the policy maker in devising penalty schemes that may produce opposite effects to the desired ones. On the one hand, only very strong monetary and nonmonetary sanctions can discourage firms from colluding. On the other, in a world of uncertainty, where the exact penalty levels which induce more collusion are not known to the authority, a large penalty makes cartel deterrence more likely, but it also increases the risk of fostering broader and tougher collusive agreements.

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