Leniency and Cartel Size: A Note on how Self-reporting Nurtures Collusion in Concentrated Markets*

Iwan Bos†

November 2006

Abstract

Leniency programs lower the expected cost of anticompetitive behavior to the extent that they allow colluding firms to pay reduced fines. This paper connects this potential adverse effect to the number of firms involved in the cartel agreement. It is shown that leniency programs may provide firms with an incentive to form cartels of limited size in concentrated markets.

JEL-codes: D43, L13, L41 and L44
Keywords: Leniency programs, Cartels, Self-reporting, Collusion.

1 Introduction

Leniency programs provide cartel members with the opportunity to report their collusive practices in exchange for a reduction of fines or even full amnesty.[1] The possibility of self-reporting is argued to be an effective method of enforcement, because it creates an incentive for insiders to disclose specific information about the conspiracy, which serves to establish a violation of the competition law. Furthermore, these programs potentially undermine internal trust relationships, thereby creating problems of maintaining the cartel. This is believed to increase the rate of detection at substantially

*The helpful comments received by Giuseppe Dari-Mattiacci, Jakob Rüggeberg, Maarten Pieter Schinkel, Giancarlo Spagnolo and participants of the Netherlands Network of Economics (NAKE) 2006 research day in Amsterdam are gratefully acknowledged. Opinions and errors are mine.

†Department of Economics and ACLE, Universiteit van Amsterdam and Tinbergen Institute. Correspondance at: Roetersstraat 11, 1018 WB Amsterdam, The Netherlands. E-mail: Iwan.Bos@uva.nl.

[1]The United States installed the program in 1978, which has been revised in 1993. The European Union followed in 1996 and adopted a new leniency notice in 2002. See, respectively, U.S. DOJ (1993) and EC (2002).

lower cost so that enforcement resources are saved.[2] Leniency programs are widely considered a success in combatting collusion.[3]

Yet, as pointed out by some scholars, a potential drawback of awarding leniency is that it lowers the expected cost of anticompetitive behavior and thereby may induce firms to collude. In their seminal contribution, Motta and Polo (2003) argue that, given that competition authorities face limited budgets, the benefits of leniency outweigh the cost, while the opposite is true, when resources are sufficient. Chen and Harrington (2005) use a dynamic numerical analysis to analyze the impact of self-reporting on cartel formation. They conclude that granting full immunity to the first firm that reports renders collusion more difficult, while partial leniency programs fail to improve a system without leniency.

The present analysis connects this potential perverse effect to the number of firms involved in the cartel. Arguably, when deciding whether or not to join, a firm will take into account the probability of taking a particular position in a potential sequence of self-reporters, unless all positions have the same expected discount.[4] In particular, the expected cost of taking part in a cartel will be, *ceteris paribus*, lower the fewer firms are involved. The potential adverse effect of leniency programs on cartel formation is formalized in a simple symmetric repeated Cournot setting. It is shown that, if full deterrence cannot be achieved, self-reporting enables firms in concentrated markets to form anticompetitive coalitions, while in markets with many players this adverse effect is negligible.

The paper is organized as follows. The next section provides a benchmark model. Section 3 extends the model by introducing two antitrust enforcement regimes, setting aside leniency programs in the first one and including such programs in the second. Section 4 concludes.

[2]The benefit of saving enforcement cost has been emphasized by Kaplow and Shavell (1994). The ability of leniency programmes to deter collusion by increasing individual incentives to cheat on partners is, among others, studied by Spagnolo (2004). Aubert *et al.* (2004) point out that leniency programs are often very helpful in gathering relevant information, thereby making conviction of conspirators more likely.

[3]Scott Hammond of the U.S. Department of Justice, for example, claimed that leniency programs have been responsible for detecting and cracking more international cartels than all search warrants, secret audio or videotapes and FBI interrogations combined (Brighton, England, November 2000). See also a speech held by Alexander Schaub who argued that the successes in antitrust enforcement in both the U.S. and EU are due to the leniency policies that are implemented in both jurisdictions (New York, U.S., January 2002).

[4]To what extent the fine is waived typically depends both on the quality of the evidence and on the position a firm takes in a sequence of self-reporters. In the U.S., for example, only the first firm that discloses information may obtain leniency. In Europe, full amnesty is granted to the first firm that reports, while partial amnesty is available for subsequent applicants if they disclose unknown and valuable information. See, respectively, U.S. DOJ (1993) and EC (2002).

2 Collusion Among the Few: A Benchmark Model

Consider a simple setting, in which on a single market with linear demand a fixed number of N identical firms is engaged in Cournot competition. Furthermore, assume average and marginal cost to be constant and equal to c. In every period, the inverse demand is given by,

$$P(Q) = a - bQ, \tag{1}$$

with $Q = \sum_{i=1}^{N} q_i$, q_i being the quantity supplied by firm i.[5] In competition, all firms earn Cournot-Nash profits that amount to,

$$\pi^N = \frac{(a-c)^2}{b(N+1)^2}. \tag{2}$$

Firms generally have an incentive to mitigate competitive pressure by coordinating actions among themselves. Implementing an output quota scheme optimally yields individual cartel profits,

$$\pi^C = \frac{(a-c)^2}{bM(F+2)^2}, \tag{3}$$

with $N = M + F$, M being the number of firms that collude and F being the number of firms that form a competitive fringe, i.e., remain independent outsiders.[6] Within this setting, however, taking part in the collusive arrangement is beneficial only when the cartel satisfies a sufficiently large part of market demand.[7] Comparing equation (2) and (3) yields the critical market share needed,

$$\frac{M}{N} = 1 + \frac{3 - \sqrt{4N+5}}{2N}, \tag{4}$$

which reaches its minimum at $N = 5$ corresponding to $\frac{M}{N} = \frac{4}{5}$.[8]

Figure 1 relates the market share of the cartel, indicated on the vertical axis, to the number of firms in the market, depicted on the horizontal axis. Plotting equation (4) yields the set of coalitions that are potentially profitable, indicated as the shaded area.

In very concentrated markets ($N \leq 4$), cartels have to be all-inclusive in order to be profitable. For instance, if $N = 4$, coalitions between two or three firms yield

[5] Moreover, assume that the inverse demand function is downward sloping, i.e., $b > 0$ and that society values the first unit of output more than its cost of production, i.e., $a > c$.

[6] Note that when the cartel is all-inclusive, i.e., $F = 0$, cartel profits equal monopoly profits $\pi^M = \frac{(a-c)^2}{4bN}$.

[7] Note that the possibility of 'tacit collusion' is excluded in this symmetric setting. Noncooperative collusion cannot emerge in equilibrium, because outsiders are always better off than insiders.

[8] This result is due to Salant *et al.* (1983) who used a Cournot model to analyze mergers. They find that a merger is profitable only if it spans at least 80% of the market. As pointed out by Deneckere and Davidson (1985), however, this approach can alternatively be used to analyze cartels.

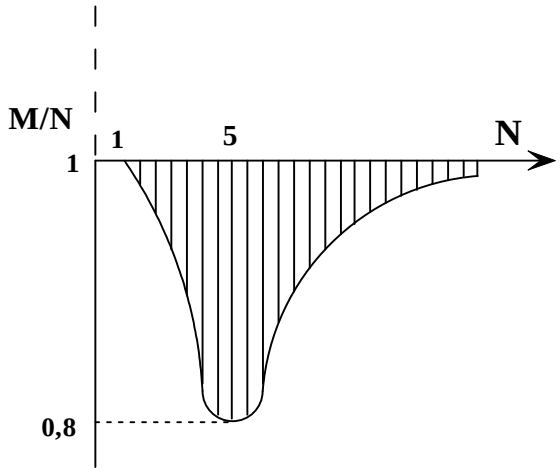

Figure 1: Stylized presentation of the set of profitable coalitions.

less profits to its members than what competition offers them. For $N = 5$, firms are indifferent between participating in a cartel consisting of four members and remaining competitors. For $N = 6$, coalitions between five or six firms generate higher individual profits compared to the Cournot-Nash situation. Finally, note that an increasing number of firms is needed to make collusion an interesting alternative. For example, if $N = 100$, at least 92 firms must collude to make participants better off.[9]

Arguably, it is easier to meet the market share requirement in markets with only a few competitors. Internal communication, for example, tends to be less complicated when the group of potential conspirators is limited.[10] Moreover, to what extent the cartel can be sustained depends on the number of market players as well. Given that remaining participants respect the agreement, optimal defection yields the chiseling firm the following gain,

$$\pi^D = \frac{(M+1)^2}{4M}\pi^C. \tag{5}$$

Note that $\pi^D \geq \pi^C$ for $M \geq 1$. Hence, independent of the size of the cartel there will always be an incentive to cheat. If we assume firms to play the above game for an infinite amount of periods they may cope with this potential instability by adopting the following 'trigger strategy'. Conspirators stick to the agreed output quota until one participant deviates, after which all others retaliate by playing the Cournot-

[9]Note that for equation (4), $N \to \infty$ yields $\frac{M}{N} = 1$, i.e., in the limit all firms must participate to make collusion worthwhile.

[10]Small groups make it easier to sustain 'trust relationships' among conspirators. From an economic perspective, the more parties are involved the more costly it is to reach and manage an agreement. This view can be traced back to Stigler (1964).

Nash strategy forever after.[11] Within this setting, cartel members will abstain from deviating when the following condition holds,

$$\sum_{t=1}^{\infty} \delta^{t-1}\pi^C \geq \sum_{t=1}^{t_0-1} \delta^{t-1}\pi^C + \delta^{t_0-1}\pi^D + \sum_{t=t_0+1}^{\infty} \delta^{t-1}\pi^N, \tag{6}$$

with t_0 being the date of defection and δ being the actual discount factor.[12] By rewriting, substituting (2), (3) and (5) in (6) and normalizing $\frac{(a-c)^2}{b} = 1$ we obtain the following necessary condition to sustain the cartel,

$$\delta \geq \delta^* = \frac{\pi^D - \pi^C}{\pi^D - \pi^N} = \frac{(M-1)^2(N+1)^2}{(M+1)^2(N+1)^2 - 4M^2(N-M+2)^2}. \tag{7}$$

The critical discount factor δ^* is increasing in N. Therefore, the cartel stability problem is, *ceteris paribus*, more severe the more firms are active in the market. Together, these results support the conventional wisdom that cartels are most easily established in concentrated industries.

3 Leniency Nurtures Small Sized Cartels

For a prospective cartel member, competition policy makes collusion more costly. Consider the simplest possible setting where these extra expected cost are given by the fine (F) multiplied by the probability that the cartel is successfully prosecuted ($\alpha \in [0,1]$). Competition policy fully deters if potential participants assess these cost to outweigh expected benefits of collusion. In the repeated Cournot framework described above, full deterrence is achieved if the following condition holds,

$$\alpha F \geq \frac{\pi^C - \pi^D}{\delta} + \pi^D - \pi^N. \tag{8}$$

Now suppose a leniency program is installed. In light of the authority's budget constraint, such a program facilitates detection and prosecution of cartels. Let $\alpha^L \in (\alpha, 1]$ denote the probability that a cartel is successfully prosecuted when members are offered the possibility to self-report. Such a program, however, lowers *ex ante* the expected cost of cartel formation. The reason is that, although the probability of being prosecuted is likely to be higher, the expected punishment will be lower. In particular, the *ex ante* expected leniency is a decreasing function of the number of participants given that the first firm that reports receives a higher 'expected discount'.

To formalize, let $L(M)$ denote the probability of receiving a certain discount, with $L'(M) < 0$. If, for example, the first firm that reports receives full immunity, while the remaining cartel members receive no discount, $L(M)$ amounts to $\frac{1}{M}$, given that a

[11] Friedman (1971) was the first to take this so-called 'supergame approach' to analyze collusion.
[12] Typically, $\delta = \frac{1}{1+r}$, with r being the relevant rate of interest.

priori all firms have an equal chance of being the first to report. Competition policy with a leniency program then fully deters cartels if the following condition holds,

$$(1 - L(M))\alpha^L F \geq \frac{\pi^C - \pi^D}{\delta} + \pi^D - \pi^N. \tag{9}$$

This condition is, *ceteris paribus*, less likely to hold, the higher is $L(M)$ corresponding to a lower number of participants. Hence, the adoption of a leniency program either yields or does not yield an increase from α to α^L sufficient to neutralize the perverse effect. The latter result is more likely if only a limited number of firms collude. In other words, if competition policy with a leniency program is not fully deterrent, cartel agreements are essentially more feasible in concentrated markets. This is illustrated in Figure 2.

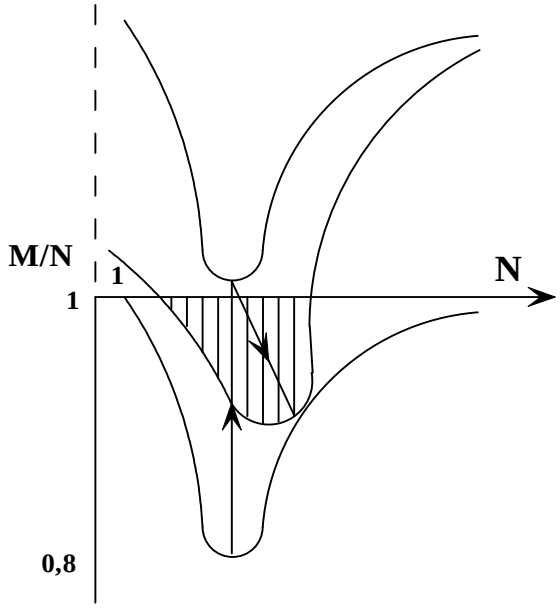

Figure 2: Stylized presentation of the impact of leniency on cartel formation.

The figure depicts the second outcome where equation (9) does not hold, i.e., a situation where the level of α^L is not high enough to offset the perverse effect of leniency programs on cartel formation. Competition policy shifts the benchmark curve upwards in a parallel fashion. In principle, full deterrence is achieved if the solid curved line is entirely above the horizontal axis. The upward shift depicted represents, in isolation, a rather extreme case in which enforcement deters all possible coalitions.[13] The countering effect, however, shifts the curve downward while rotating

[13]In practice, the upward shift may not be as drastic so that the curved line will not be entirely above the horizontal axis. This, however, does not change the results in a fundamental way.

it counterclockwise. The downward movement is caused by the discount that leniency offers. The rotation is due to the presence of different discounts depending on the position in the reporting sequence. Typically, being (one of) the first yields a higher discount. The rotation is most pronounced when only the first receives full amnesty, while no leniency is available to the other cartel members.[14] The shaded area marks the set of coalitions that yield members higher expected profits than in competition. The size and shape of this area depends on the specific leniency scheme adopted. In particular, as long as the leniency program grants significantly more amnesty to the first firm that reports (strong rotation), it will create opportunities to collude in concentrated markets. At the same time, such a program will have a negligible effect on markets with many players (in the limit the middle and upper curves drawn will coincide). Therefore, if the increase from α to α^L is not sufficient, leniency creates additional opportunities for cartels with a few members to emerge in concentrated markets.

4 Concluding Remarks

In this paper, it has been shown that, if full deterrence cannot be achieved, the potential pro-collusive effect of leniency programs is asymmetric to the extent that it may induce collusion among a relatively small number of firms. Combined with the insight that a cartel must take a dominant position in order to be sufficiently attractive this leads to the conclusion that the perverse effect is most pronounced in concentrated markets. Unfortunately, it is well-known that cartels are more easily established in oligopolistic markets even without competition law enforcement.

One possible remedy may be to increase the level of fines significantly so that expected discounts are insufficient to make any coalition profitable. Fines imposed, however, are typically constrained by an upper bound laid down in competition law. In light of the fact that fines cannot be raised sufficiently, the analysis supports the view that competition authorities should, *ceteris paribus*, spend more resources on detecting cartels in more concentrated markets.

[14] Note that, in the extreme case, where all firms are granted the same leniency, the rotation effect would be absent.

References

[1] Aubert, C., P. Rey and W. Kovacic, 2004, "The Impact of Leniency and Whistle-blowing Programs on Cartels," forthcoming in *International Journal of Industrial Organization*;

[2] Chen, J. and J.E. Harrington, 2005, "The Impact of the Corporate Leniency Program on Cartel Formation and the Cartel Price Path," forthcoming in: *Political Economy of Antitrust*, V. Ghosal and J. Stennek (eds.);

[3] Deneckere, R. and Davidson, C., 1985, "Incentives to Form Coalitions with Bertrand Competition," *RAND Journal of Economics*, 16(4), 473-486;

[4] European Communities, 2002, "Notice on Immunity from Fines and Reduction of Fines in Cartel Cases," OJ C 45/3;

[5] Friedman, J.W., 1971, "A Non-cooperative Equilibrium for Supergames," *The Review of Economic Studies*, 38(1), 1-12;

[6] Kaplow, L. and S. Shavell, 1994, "Optimal Law Enforcement with Self-Reporting of Behavior," *Journal of Political Economy*, 102(3), 583-606;

[7] Motta, M. and M. Polo, 2003, "Leniency Programs and Cartel Prosecution," *International Journal of Industrial Organization*, 21, 347-379;

[8] Salant, S., S. Switzer and R. Reynolds, 1983, "Losses Due to Merger: The Effects of an Exogenous Change in Industry Structure on Cournot Nash-Equilibrium," *Quarterly Journal of Economics*, 48, 185-200;

[9] Spagnolo, G., 2004, "Divide et Impera: Optimal Leniency Programs," *CEPR working paper series*, no. 4840, 1-48;

[10] Stigler, G.J., 1964, "A Theory of Oligopoly," *Journal of Political Economy*, 72(1), 44-61;

[11] United States Department of Justice, 1993, "Corporate Leniency Policy," www.usdoj.gov.