Department of Economics

Three Essays in Competition Policy

Dimitrios Magos

Thesis submitted for assessment with a view to obtaining the degree of Doctor of Economics of the European University Institute

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Part I

Introduction

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Abstract

This thesis focuses on different aspects of Competition Policy and analyses questions related to market power, collusion and the European Commission's fining policy. The first chapter provides a theoretical setting to study a particular abuse of dominant position, known as margin (or price) squeeze. It explores the conditions under which margin squeeze arises as an equilibrium outcome and discusses policy implications of introducing price squeeze testing. In the field of cartel detection, the leniency program has been instrumental in competition authorities' fight against cartels. This is the topic of the second paper, which examines the deterrence effect of the leniency program in a setup where all cartels are failing cartels. The third chapter provides an overview of the fining decisions of the European Commission in the field of antitrust. It analyses the incentives of firms to appeal Commission infringement decisions and examines whether the fining Guidelines have led to lower appeal rates, possibly through providing greater transparency in the way fines are set.

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Introduction

This thesis consists of three papers on competition economics. In this introduction I will describe the motivation and the main results of each of the papers.

The first paper focuses on the exclusionary practice of price squeeze. Following the liberalization of national network monopolies, potential entrants need to acquire access at the incumbent's network in order to serve consumers in the downstream market. Entrants often complain to antitrust authorities that the price margin between the access price they pay to the incumbents to get access at the network and the downstream price is not sufficient to cover the downstream costs (see cases Telefonica, Wanadoo, Deutsche Telekom). The European Commission has argued that such a pricing strategy constitutes an exclusionary practice. However, from the theoretical point of view it is not clear ex ante whether the incumbent firms would have an incentive to engage in such a practice (one monopoly profit argument).

The paper explores the conditions under which margin squeeze can arise by analysing a two stage game between a vertically integrated firm and a downstream competitor. Foreclosure incentives can arise as an equilibrium outcome since the vertically integrated firm suffers from a time inconsistency problem: it cannot commit to not undercut its rival firm once it has granted access to its network. Therefore, in anticipation of strong downstream competition the incumbent firm might prefer to exclude altogether or raise the costs of its competitor. I show that the incentives of the incumbent depend on the type of competition (including the degree of differentiation of the downstream products), on the relative downstream costs of the two firms, on the relative importance of the upstream costs and on the size of the demand. Also the relative merits of price squeeze testing are assessed compared to other remedies such as structural remedies and regulation.

The second chapter studies the deterrent effect of leniency programs. Much of the recent success of antitrust authorities in detecting and prosecuting cartels has been attributed to the introduction of leniency programs. However, some critics claim that leniency programs would only capture failing cartels. This raises concerns since leniency applications could suck up antitrust authorities' resources without necessarily enhancing deterrence. More specifically, there would be no procompetitive effect from such applications since these cartels would fail in any case. At the same time deterrence may be reduced since the leniency policy inherently lowers the fine for the firm that reports the illegal activity.

In this chapter, I present a model of imperfect information where only firms participating in failing cartels would apply for leniency. In this setting, leniency applications are

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triggered when the cartel participants realize that the cartel activity would collapse in the following period. Contrary to the critics, I show that leniency programs can actually enhance deterrence by placing firms into a Prisoner's Dilemma situation which dominates any reduction in the fines. Leniency programs would be anticompetitive only for very significant detection rates. However at such high rates collusion would not be sustainable in the first place. Therefore, the introduction of the leniency program is never anticompetitive in the framework of failing cartels.

The third paper provides an extensive analysis of the European Commission fining decisions in the field of antitrust. Fines are a fundamental pillar of punishing infringements of antitrust rules. However, there has been an increasing unease in the European Competition Policy with the high proportion of cases that are appealed. There has been criticism that a major factor behind these appeals has been the obfuscation surrounding how the Commission decides on the level of the imposed fines. In 1998 the European Commission published Guidelines on the calculation of fines to enhance transparency and these were complimented by a new set of Guidelines in 2006. However, a significant number of firms still resort to litigation.

In the paper I perform an econometric analysis of the probability of appealing Commission decisions. The role of the Guidelines appears significant. Following the 2006 Guidelines firms that have been fined are less likely to appeal Commission decisions after controlling for other relevant variables. Also following the 1998 Guidelines the European Courts have awarded lower reductions in the fines set in the Commission decision.

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Part II

Three Essays on Competition Policy

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CHAPTER 1

DO INCUMBENT FIRMS HAVE AN INCENTIVE TO PRICE SQUEEZE?

1.1 Introduction

Article 102 of the Treaty on the European Union and Sherman Act Section 2 prohibit respectively the "abuse of dominant position" and "monopolisation, attempts and conspiracies to monopolise". The strategy of price (or margin) squeeze is one of the several foreclosure strategies such as tying, bundling, predation or refusal to deal, that dominant[1] firms may employ in order to exclude rival firms. Price squeeze arises when a vertically integrated dominant firm, that in the extreme case could be an upstream monopolist, uses its control over an input of the production of the downstream good in such a way that does not allow an efficient rival firm(s) to make a profit in the downstream market, where the integrated firm also operates.

The question that arises is whether, and under what conditions, price squeeze constitutes a profitable strategy for the vertically integrated firm. According to Geradin and O'Donoghue (2005), price squeeze may arise if the essential input represents an essential facility[2] with no cheap bypass been available. Furthermore, they argue that it should constitute a relatively high, fixed portion of the downstream costs. These arguments appear plausible, however, a theoretical framework seems also necessary.

The price squeeze test has raised a lot of controversy in light of recent high profile decisions on both sides of the Atlantic on whether it should be considered a separate antitrust infringement (see Carlton (2008) and Sidak (2008)). Several critics of price squeeze testing argue that other legal tests such as refusal to deal, predation and excessive pricing are sufficient to address foreclosure concerns. They argue that if upstream and downstream prices are independently compatible with antitrust rules then a price squeeze test would only protect potential entrants.

[1] Dominance is defined in the Commission Guidance Paper (2008) as "a position of economic strength enjoyed by an undertaking, which enables it to prevent effective competition being maintained on a relevant market, by affording it the power to behave to an appreciable extent independently of its competitors, its customers and ultimately of consumers".

[2] Essential facility is a facility that is prohibitive to duplicate and access to it is indispensable for entry in the downstream market.

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The aim of the paper is twofold. First, to provide an analytical framework to analyse under which circumstances (if any) price squeeze can constitute a rational business strategy for the vertically integrated firm. We examine how the level of competition in the downstream market may affect such incentives, by considering different forms of competition at the downstream level. Second, we consider whether introducing price squeeze testing improves social welfare and whether other antitrust infringements address price squeeze concerns.

In the first part of the paper (section 2) we introduce the general setup of the market under consideration, we discuss the alternative versions of the price squeeze test and we provide a short overview of price squeeze cases in EC law and in the US. The second part analyses the incentives of the firms to price squeeze. The starting point of the analysis is the contrasting views of the Chicago school - arguing that price squeezing, and more generally foreclosure strategies, cannot constitute a rational business plan- and more recent Industrial Organisation models that provide theoretical settings where foreclosure strategies are viable (section 3). We show that total foreclosure may arise when firms compete strongly in the downstream market (section 4) while only partial foreclosure may arise under quantity competition (section 5). Section 6 extends the analysis to differentiated products; section 7 concludes.

1.2 Market structure and test format

1.2.1 The general framework: notation and market structure

In our framework there are two levels of production, the upstream and the downstream market. The incumbent firm, denoted as I, is a vertically integrated firm that is an upstream monopoly, i.e. it holds an essential facility in the upstream market, but also operates in the downstream market. In the downstream market there is also a potential entrant, firm E. In order to operate in the downstream market firm E needs to gain access to firm I's essential facility. Firm I charges a per unit access price, A, to firm E to grant such an access. Therefore, firm E is at the same time a customer and a competitor of the vertically integrated firm.

A simple example of this setup is the telecommunication sector. The vertically integrated firm is a national incumbent such as Telecom Italia or Deutsche Telekom that operates the network but also supplies broadband and other telecom services to final consumers. The potential entrant is a firm such as Tele2 that, without (necessarily) establishing its own network, supplies services to consumers.[3]

[3]The general framework is relatively broad and can be applied to any market where there is an upstream monopolist controlling an essential facility (e.g. network industries, manufacturing)

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The cost structure is as follows: Firm I has an operating marginal cost, V, in the upstream market while the costs in the downstream market are denoted Ci and Ce for the vertically integrated firm and the entrant respectively. Firm E is assumed throughout to be more efficient than firm I, i.e. $Ce < Ci$. We also assume that there are no fixed costs. Furthermore, there is a fixed proportions technology i.e. one unit of good produced in the downstream market requires one unit of the upstream input, and there are no interoperability costs. The final prices for end users are denoted Pi and Pe or simply P when the good is homogeneous. The demand is given by

$$P = Z - q$$

where [4]

$$Z > \max(Ce + A, V + Ci) \tag{1.1}$$

1.2.2 The appropriate test format

Price squeeze arises when an 'equally or reasonably efficient service provider' cannot obtain a normal profit in the downstream market. The first question that arises is which firm, the dominant firm's own downstream operation or the potential entrant, is expected to obtain a normal profit downstream. The two alternative formats therefore are:

$$\text{Equally efficient competitor test : } P - A \geq Ci \tag{1.2}$$

$$\text{Reasonably efficient competitor test : } P - A \geq Ce \tag{1.3}$$

In our setup $Ci > Ce$ and therefore the first version is more difficult to 'pass' for the incumbent. The former version of the test also corresponds to the efficient component pricing rule (ECPR). This rule suggests that the optimal access price should be equal to the sum of the direct cost and the opportunity cost of the vertically integrated firm to grant access to its rival, namely in our setup

$$A = V + (P - (V + Ci)) = P - Ci$$

On the other hand, the reasonably efficient competitor test might be preferable from a welfare perspective given that the rival E is more efficient than I. Otherwise, an unnecessarily

[4] Condition (1.1) is required to guarantee that there would be sufficient demand for the product when either the incumbent or the potential entrant operates in the market.

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too high price floor would be imposed to final consumers. In this spirit, Brunekreeft et al (2005) suggest that a test of the form

$$P \geq A + min(Ci, Ce)$$

should be performed. Also, under both the equally and the reasonably efficient competitor test, inefficient entry ($Ce > Ci$) is discouraged.

Further issues on the appropriate test format are provided in Appendix 1.9.1.

1.2.3 Price squeeze in the US and EC law

In the US, there has been a vivid discussion on whether price squeeze should constitute a separate antitrust violation. Price squeeze was recognised as an antitrust liability in *Alcoa*[5] in 1945. This judgment was based on concepts of fair pricing and living profit which, according to several commentators, are hard to reconcile with today's antitrust focus on consumer welfare.[6] In 2004, the *Trinko*[7] judgment warned against the use of antitrust rules to impose duties to deal on dominant firms. The judgment suggests that if a dominant firm is not subject to a duty to deal it is not obliged to guarantee a minimum level of assistance in the provision of services to rivals. This logic would preclude price squeeze claims when there is no duty to deal. Following a series of conflicting cases, the Supreme Court reinstated *Trinko*'s logic in *LinkLine* stating that "if there is no duty to deal at the wholesale level and no predatory pricing at the retail level, then a firm is certainly not required to price both of these services in a manner that preserves its rivals' profit margins".[8]

In EC competition law there have been a few formal price squeeze decisions where the Commission and the European Courts appear to suggest that price squeeze may constitute a "clear-cut abuse". The first case is the *National Carbonising* (1975) [9] where the price squeeze was detected based on the costs of a reasonably efficient manufacturer in the downstream market. In *Napier Brown/British sugar* case (1988)[10] the European Court of Justice (EcJ) found that there has been an antitrust violation based on the equally efficient competitor test, claiming that the margin was insufficient to "reflect the dominant company's own costs of transformation". The Court of First Instance (CFI) judgment on the case of *Industries des Poudres Shperiques* (IPS)[11] in 2000 reaffirmed that price squeeze would be detected when

[5] United States v. Aluminum Co. of Am., 148 F.2d 416 (2d Cir. 1945)
[6] See for example Faella and Pardolesi (2009)
[7] Verizon Communications Inc., Petitioner v. Law Offices of Curtis V. Trinko, LLP., 540 U.S. 398, (2004)
[8] Pacific Bell Telephone Co. v. Linkline Communications. Inc. [2009] USSC, Case No. 07–512 [Pacific Bell Telephone v. Linkline Communications]
[9] Commission Decision 29 October 1975, OJ 1976 L35/6.
[10] Commission Decision 18 July 1988 88/518/EEC, OJ 1988 L2 84/41.
[11] Case T-5/97 Industrie des Poudres Shperiques SA vs Commission (2000) ECR II-3755

an equally efficient competitor could not compete. *Deutsche Telekom* (DT)[12] was fined in 2003 for charging more its competitors for unbundled broadband access than the final retail price it was charging the consumers, i.e. $P - A < 0$.[13] DT was condemned even though the access price had been subject to ex ante approval by the German regulator, regTP.[14] In the 2008 appeal judgment of the DT case, the CFI confirmed that price squeeze is a separate infringement of article 82 EC (now 102 TEU), even if the access price is regulated. In 2007, it was *Telefonica*'s turn to be condemned by the European Commission for the Spanish market of broadband services.[15] Finally, the Guidance paper on article 82 EC (now 102 TEU) explicitly mentions price squeeze among the priorities of the Commission enforcement and price squeeze abuse is grouped together with refusal to deal.

A thorough review of price squeeze cases by Geradin and O'Donoghue (2005) suggests that in the EU, price squeeze cases are more frequent at the national level, in the decisional practice of regulatory and competition authorities as well as national courts. They conclude that in late years such cases of price squeeze, especially in the telecommunication sector, have multiplied transforming the question of price squeeze from an "obscure issue that belonged to the realms of academic discussion, .. into an .. intensely debated practical issue in the area of telecommunications".[16]

1.3 Foreclosure incentives and the Chicago school

In this part we review the arguments regarding the incentives of a vertically integrated firm that is a monopolist upstream to resort to foreclosure strategies. The underlying idea of the Chicago school suggests that the vertically integrated firm has no incentive to foreclose, simply because it is not a rational business plan; it could make more profits by allowing the (more efficient) rival firm to enter because there is "one monopoly profit" to be captured. On the other hand, the foreclosure doctrine suggests that the vertically integrated firm may have an incentive to foreclose entry either to extend upstream market power or to protect its upstream monopoly.[17] In our setting foreclosure will arise due to the inability of the vertically integrated firm to solve its commitment problem.

[12] Commission Decision 21 May 2003 OJ 2003 L 236/9.

[13] In this case the Commission suggested that the relevant version of the test is the equally efficient competitor test.

[14] This contrasts with the the US case law in *Trinko* where it is suggested that once an industry is regulated then it is exempted in some sense from antitrust concerns.

[15] Commission Decision 4 July 2007 Case COMP/38.784, Wanadoo España/Telefónica

[16] Geradin, D., O'Donoghue, R. (2005) p2.

[17] Several theories that incorporate imperfect information have been developed to explain foreclosure incentives. For an analysis of different theories on foreclosure strategies see Motta (2004) chapter 7.

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1.3.1 Chicago School (no commitment problem)

The Chicago school proponents (ex Bork (1978)) argue that a test for price squeeze is superfluous even when the access price can be set freely by the vertically integrated firm.[18] The idea is that firm I would have no incentive to foreclose efficient entry since an upstream monopolist can reap all the benefits from the entry of a more efficient entrant downstream.

Firm I has effectively two choices. One is to foreclose which can be achieved by setting a price at the monopoly level

$$P = \frac{Z + V + Ci}{2} \tag{1.4}$$

and charging a high access price, A, where $P - A < Ce$.

Alternatively, it can choose an access price at the monopoly level but ensuring that $P - A \geq Ce$ and the rival firm could enter. Assuming that the downstream competitor has no market power[19] then downstream prices are set at marginal cost and $P = Ce + A$, with the entrant(s) serving the whole downstream market. Firm I could set the access price to extract all the profits of the entrant(s) with

$$P = \frac{Z + V + Ce}{2} \tag{1.5}$$

Therefore, a monopoly price arises but now firm I "outsources" its downstream production to a more efficient firm, firm E. If, as assumed, firm I is less efficient than firm E and given that profits are a decreasing function of costs, firm I would prefer to grant access. This example demonstrates that firm I will choose to foreclose only when it is more efficient than its rival, raising no productive efficiency concerns. Therefore, the entrant serves the market while firm I reaps all the profits.[20]

Proponents of the Chicago school would suggest that if a price squeeze case is detected it could well be for entirely legitimate reasons. For example, low downstream prices could be set as a temporary marketing device for the introduction of new goods or because of the sale of a complementary product.

[18] When the access charge is regulated, firm I does not possess A as an instrument to reap the profits of the entrant. Firm I would then be able to foreclose only through low downstream prices, i.e. predate. However, the Chicago school proponents would suggest that a firm would have no incentive to predate since this is simply inefficient destroying industry profits. For a thorough discussion see Motta (2004), chapter 7.

[19] For example because there are many such potential entrants.

[20] The original Chicago school example considers an upstream monopolist and perfectly competitive downstream firms that are not related with the upstream firm. The argument is that the bottleneck owner would not have an incentive to vertically integrate to extend its monopoly power to the downstream segment; it can simply exercise its monopoly power on the bottleneck- there is a single source of monopoly profit. On the other hand "imperfect" competition in the downstream market could create distortions that could create such incentives to vertically integrate (double marginalisation).

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1.3.2 Foreclosure incentives

More recent economic theory suggests that an upstream monopolist faces a commitment problem that may not allow it to extract all the monopoly profit (Hart and Tirole (1990)). An upstream monopolist facing several downstream buyers may not be able to commit to restrict sales at the monopoly level. The profit maximising strategy, as discussed above, would be to set the input price at the monopoly level. However, once it agrees this with the first buyer, the upstream monopolist would have an incentive to sell to the second buyer. Anticipating this strategy of the monopolist the first buyer would not accept an access price set at the monopoly level since it would risk making its business loss making. As a result the commitment problem of the monopolist limits its ability to exploit its monopoly power (similar to durable goods monopolist). Hart and Tirole (1990) suggest that through vertical mergers a monopolist acquires a direct stake on the downstream profits which will allow it to credibly commit not to offer secret price cuts to rivals (restoring monopoly power).

The question that arises is whether, for example following such a merger, a vertically integrated firm that is an upstream monopolist still has an incentive to discriminate against the potential entrant. In the extreme case it might refuse to grant access to its input altogether, or it might want to employ other foreclosure strategies such as price squeeze.

In this paper we demonstrate that a vertically integrated firm might not be able to fully restore its monopoly power through vertical integration since the mere existence of its downstream operations limits its ability to set monopoly access pricing. As a result, firm I might benefit from excluding a customer (firm E) when the extra profits it can get in the downstream market because of the greater market power it would enjoy are significant. More specifically it would have an incentive to foreclose if the reduction in demand for its upstream input is offset by additional sales downstream. The incentive therefore would depend on the relative profitability of the upstream and the downstream market. The higher the upstream margin relative to downstream profits the greater the disincentive to engage in price squeeze. We also demonstrate that the degree of product differentiation is an important parameter to this respect. When the products are perfectly differentiated the incumbent firm would have no incentive to foreclose the entry of firm E. The downstream firms will be serving different markets and by excluding firm E, firm I would simply lose its customer.

The nature of the commitment problem that firm I faces can be illustrated in the Chicago School example given above. As long as firm I cannot credibly commit not to compete in the downstream market once it has granted access to its input, the Chicago School outcome suggested above is not subgame perfect. In other words, monopoly access pricing is not incentive compatible when firm I can influence the price in the downstream market. The

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monopoly price might be higher than the own costs of the incumbent firm as long as

$$P^m = \frac{Z + V + Ce}{2} > (V + Ci) \Leftrightarrow Z - V - Ci > Ci - Ce \tag{1.6}$$

The entrant will anticipate that once he pays the access price to the dominant firm, firm I could undercut him and serve all the downstream market, making extra profits but at the same time obliging firm E to make negative profits. Firm E, anticipating this behavior, would not accept such an access price in the first place. Therefore even if the monopoly profits under the Chicago school scenario are strictly higher for firm I than in the foreclosure case, firm I faces an incentive problem which as we demonstrate in sections 4-6 may lead to foreclosure.[21]

Therefore, the very nature of vertical integration could create incentives to discriminate against the potential entrant. On the other hand, the vertically integrated firm may still prefer to exploit the productive efficiency of firm E and not (totally) foreclose. From a social welfare perspective vertical integration provides some advantages, notably a positive effect on double marginalisation, however, firm E is less likely to produce which leads to productive inefficiency. Hence, these two effects would have to be balanced out.[22] In what follows, we analyse how the aforementionted effects intertwine and how the type of competition downstream affects the incentives of the vertically integrated firm to foreclose. Furthermore, in this setup the effects of introducing a price squeeze test are assessed and contrasted with other antitrust infringements, notably predation, and other potential remedies.

Other related literature include Ordover, Saloner and Salop (1990). In a setting of upstream competition (i.e. no monopolist upstream) they show that vertical integration might benefit the downstream division of the integrated firm by reducing competition in the upstream market. This might increase the market power of the remaining upstream oligopoly firms leading these firms to raise prices to the downstream competitors. This effectively raises rival's costs, also referred to as partial foreclosure.[23] However, this hinges on the ability of the integrated firm to commit not to serve downstream competitors. Another rationale for foreclosure in the downstream market is to deter entry in the upstream market (Carlton and Waldman (2002)).

[21] Indeed an analysis (similar to the Bertrand case) reveals that foreclosure will arise when $Z - V - Ci < 4(Ci - Ce)$ when there is perfect competition in the downstream market.

[22] Other potential advantages of vertical integration include reduction of transaction costs, economies of scope, better provision of services. These beyond the scope of this paper. For more on vertical integration see Motta (2004), chapter 6.

[23] As opposed to total foreclosure when entrants are deterred from entering.

1.4 Price (Bertrand) Competition

1.4.1 Price Competition analysis

We first consider the case where the firms compete in prices à la Bertrand in the downstream market.

The timing of the game is as follows:

In stage 1, firm I decides what price to charge to firm E for granting access to its essential facility.

In stage 2, firms I and E compete in prices in the downstream market.

Given the timing of the game firm I does not have the market power to determine the price in the downstream market as it cannot commit that it will not intervene in the downstream market if it can produce cheaper than firm E i.e. firm I faces the incentive problem explained above.

Proposition 1.1 *Under downstream Bertrand competition, firm I will prefer to foreclosure when* $Z - V > 5Ci - 4Ce$

Proof: We solve for the Subgame Perfect Nash Equilibrium.

In the **second stage**, price competition in the downstream market implies that the more competitive firm serves the market while the other one remains inactive. When there are small cost asymmetries (case Ai), price equals the costs (upstream and downstream) of the less competitive firm. The winner of the market needs only to undercut slightly the rival up to the point that the latter cannot produce profitably anymore.[24] When there are large cost asymmetries, firm E is able to set monopoly pricing.

The total costs of production for the two firms are $V + Ci$ and $A + Ce$ respectively. Since the access price is a choice variable in the first stage we need to distinguish two broad cases of entry (Ai and Aii) and foreclosure (B).

Case Ai: Entry Bertrand pricing. When $V + Ci > A + Ce$ firm E serves the market. When $V + Ci < \frac{Z+A+Ce}{2}$, then the small cost asymmetries Bertrand outcome arises and

$$P = V + Ci \tag{1.7}$$

[24] When the cost asymmetries between the firms are relatively small then **any** pair of prices where the least efficient firm charges a price between its own marginal costs and the marginal costs of the most efficient firm and where the most efficient just undercuts this price constitutes a Nash equilibrium. At the same time, simple selection criteria, such as Pareto dominance or elimination of weakly dominant strategy, select the Nash equilibrium where the least efficient firm charges its marginal cost and the most efficient firm slightly undercuts it. In the limit we shall assume that the least efficient firm charges the marginal cost of the relatively inefficient firm.

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In this case, the downstream price is "completely" determined in the second stage (since it is not a function of A) and the profit of the vertically integrated firm and of the entrant are given respectively by[25]:

$$\Pi_I^{B,E} = (A - V)(Z - V - Ci) \tag{1.8}$$

$$\Pi_E^{B,E} = (V + Ci - A - Ce)(Z - V - Ci) \tag{1.9}$$

Hence, the total profits to be split among the two firms are

$$\Pi_{Total}^{B,E} = (Ci - Ce)(Z - V - Ci) \tag{1.10}$$

that represents the productive efficiency that is brought in the market by the entrant firm.

Case Aii: Entry Monopoly pricing. When there are large cost asymmetries $V+Ci > \frac{Z+A+Ce}{2}$, firm E charges the monopoly price

$$P^{B,M} = \frac{Z + A + Ce}{2} \tag{1.11}$$

since it is lower than the marginal cost of the incumbent. Hence the incumbent cannot profitably undercut this level of pricing. Firm I's profits are

$$\Pi_I^{B,M} = (A - V)(\frac{Z - A - Ce}{2}) \tag{1.12}$$

Case B: Foreclosure. When $V + Ci < A + Ce$, firm I serves the market and sets

$$P = A + Ce \tag{1.13}$$

The profit of firm I in the downstream market is given by

$$\Pi_I^{B,F} = (A + Ce - V - Ce)(Z - A - Ce) \tag{1.14}$$

while the entrant makes no profits. Therefore given that A is chosen by firm I in stage 1 this case amounts to firm I being a monopolist.

In the **first stage**, firm I can either choose A to allow entry or set A at prohibitively high level, effectively foreclosing the downstream market.

[25] Subscripts denote the firm (I or E) while the superscript denote the type of competition, Bertrand (B) or Cournot (C) and whether there is Entry Bertrand pricing (E), Entry Monopoly pricing (M) or Foreclosure (F).

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Case Ai: Entry Bertrand pricing. Firm I chooses A such that

$$\begin{aligned} & max_A \Pi_I^{B,E} \\ s.t.\ V + Ci &\geq A + Ce \text{ (entry condition) and} \\ V + Ci &< \frac{Z + A + Ce}{2} \text{ (small cost asymmetries)} \end{aligned}$$

Since profits are an increasing function of the access price the entry condition should bind, namely

$$A^{B,E} = V + Ci - Ce \tag{1.15}$$

Note that this is the maximum access price that allows the entrant to serve the market and make nonnegative profits. The profits for the vertically integrated firm and the entrant are respectively

$$\Pi_I^{B,E} = (Ci - Ce)(Z - V - Ci) \tag{1.16}$$

$$\Pi_E^{B,E} = 0 \tag{1.17}$$

Hence, firm I can appropriate all the profit that is brought in the market by the higher efficiency of firm E.[26]

Case Aii: Entry Monopoly pricing. Firm I maximises its profits

$$max_A \Pi_I^{B,M}$$

$$s.t. V + Ci \geq A + Ce \text{ (entry condition) and}$$

$$s.t. V + Ci > \frac{Z + A + Ce}{2} \text{ (large cost asymmetries)} \tag{1.18}$$

The optimal access and downstream price as well as firm profits are given by

$$A^{B,M} = \frac{Z - Ce + V}{2} \tag{1.19}$$

[26] Given our setup firm I has all the bargaining power concerning the distribution of the profits brought in the industry. This assumption makes foreclosure less likely. Imagine that firm I would have a zero profit in an entry scenario then of course it would prefer foreclosure.

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$$P^{B,M} = \frac{3Z + Ce + V}{4} \tag{1.20}$$

$$\Pi_I^{B,M} = \frac{(Z - V - Ce)^2}{8} \tag{1.21}$$

$$\Pi_E^{B,M} = \frac{(Z - V - Ce)^2}{16} \tag{1.22}$$

This case can arise only when (1.18) holds i.e. substituting (1.19)

$$(Z - V - Ci) < \frac{1}{3}(Ci - Ce) \tag{1.23}$$

Case B: Foreclosure. Firm I maximises its profits with respect to A given the pricing condition, equation (1.13)

$$max_A \Pi_I^{B,F} = (A + Ce - V - Ci)(Z - A - Ce) \tag{1.24}$$

$$\text{s.t. } A > Ci + V - Ce \text{ (no entry condition)} \tag{1.25}$$

The solution to this maximization problem is to set an access price that results in the monopoly price[27]

$$P^F = \frac{Z + V + Ci}{2} \tag{1.26}$$

$$A^F = \frac{Z + V + Ci}{2} - Ce \tag{1.27}$$

The profits of the vertically integrated firm are

$$\Pi_I^{B,F} = \frac{(Z - V - Ci)^2}{4} \tag{1.28}$$

Foreclosure may arise The vertically integrated firm will choose A depending on which case yields the highest profits for it; that is whether the productive efficiency gains compensate firm I for the loss in its monopoly profits. Therefore firm I will foreclose when firm I's profits in the foreclosure scenario exceed its profits in entry, (1.28) > (1.16) or

$$Z - V > 5Ci - 4Ce \tag{1.29}$$

[27] Note that (1.27) satisfies the condition for no entry, given (1.1)

This proves Proposition 1.1.[28]

Inequality (1.29) is more likely to arise, and hence foreclosure may arise, when the cost difference between the firms is small and when the upstream costs are relatively small. When demand is relatively high (Z is high relative to the cost parameters) the incumbent would prefer to serve the market itself since the profit margin it can make is relatively significant. Interestingly, entry may be foreclosed even when the entrant has low costs relative to the incumbent as long as Z (the demand) is very high.

Also, if the entrant is relatively efficient compared to the incumbent the latter will prefer to exploit the productive efficiency of firm E rather than foreclose entry. On the other hand, when the cost difference is small, firm I prefers to monopolise the downstream market. Also as seen from (1.16), in the entry scenario the profit margin that firm I enjoys depends on the productive efficiency of firm E compared to firm I. The smaller the cost difference is the lower the access price that firm I is able to credibly set (since firm I will be able to undercut firm E for a greater range of parameters) and therefore the lower the profits for firm I.[29] As a result, when the cost difference is relatively small firm I prefers to foreclose entry and act as a vertically integrated monopolist. In other words, it is not profitable for firm I to extract the productive efficiency of the entrant rather than enjoy the monopoly profits of its own (albeit less efficient) downstream operations.

Welfare analysis In the welfare analysis we only consider the Entry Bertrand pricing and Foreclosure cases since the comparison of these two conditions determines the choice of firm I to foreclose entry or not.

Lemma 1.1 *Under foreclosure social welfare is lower compared to the entry scenario.*

In the (Bertrand pricing) entry case the downstream price as well as the profits of the firms do not depend on the access charge, A. The social surplus, W, is given by the sum of the incumbent profits (equation (1.16)) and the consumer surplus, S.

$$S^{B,E} = \frac{(Z - V - Ci)^2}{2} \tag{1.30}$$

$$W^{B,E} = \frac{1}{2}(Z - V - Ci)^2 + (Ci - Ce)(Z - V - Ci) \tag{1.31}$$

[28] Note that under Entry firm I can always receive at least (1.16) and in the parameter range (1.18) it receives the max ((1.16),(1.21)).

[29] The incumbent might prefer to set an even higher access price (at monopoly level), however at that level firm E would anticipate that firm I cannot credibly commit not to compete with firm E in the downstream market.

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In the foreclosure case the monopoly price is charged, namely $P^F = \frac{(Z+V+Ci)}{2}$. The social surplus is exactly at the level it would be when a monopoly with costs $V + Ci$ sells the final good. Consumer surplus and (combined with (1.28)) total welfare are

$$S^{B,F} = \frac{(Z - V - Ci)^2}{8} \tag{1.32}$$

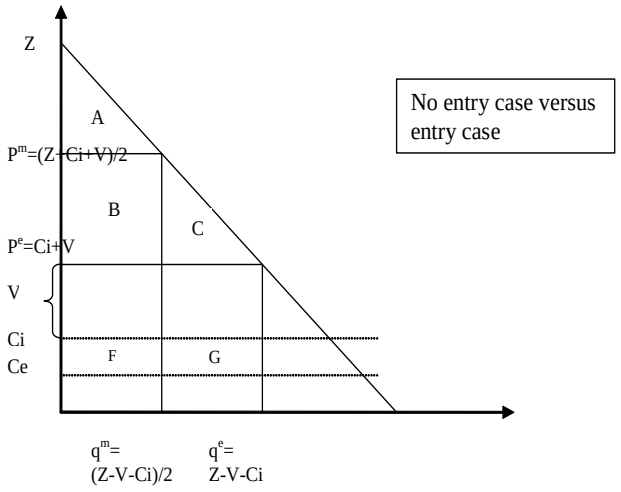
$$W^{B,F} = \frac{3(Z - V - Ci)^2}{8} \tag{1.33}$$

with (1.33) < (1.31).

Comparing equations (1.30) and (1.33), we observe that the social welfare under foreclosure is lower than the consumer surplus alone under (Bertrand pricing).[30]

In a nutshell, $W^F < S^E < W^E$. The first inequality reflects the allocative inefficiency from monopolization whereas the second one reflects the productive inefficiency when firm I is producing in the foreclosure case.

We can depict the social welfare analysis in the diagram below. In the foreclosure case the incumbent makes profits equal to B whereas the total welfare is $A + B$. In the entry case the profits of firm I (and total profits) is represented by area $F + G$. Consumer surplus is area $A + B + C$. When $B > F + G$ firm I has an incentive to price squeeze. Note that from a social welfare point of view this is undesirable since there is a net benefit of the areas $C + F + G$ when there is entry in the downstream market.



[30] Therefore, if consumers could coordinate among themselves they could compensate the incumbent to allow entry.

Furthermore, the socially optimal outcome is not achieved under neither scenarios.[31] When there is perfect competition both upstream and downstream, prices simply equal marginal cost and the Social Surplus is simply the consumer surplus

$$W^C = \frac{(Z - V - Ce)^2}{2} \tag{1.34}$$

Nature of the Price Squeeze We have analysed the optimal strategies of the vertically integrated firm and showed that firm I behaves anti-competitively (since by Lemma 1.2 social welfare is lower under foreclosure than under Bertrand pricing Entry) if inequality (1.29) is satisfied. It can employ the instrument that it processes, namely the setting of A, to foreclose entry even if from a socially point of view this is not beneficial.

The question that arises is whether existing competition policy tests can deal with this strategy of the incumbent or there is a need for a tailor made test. Interestingly, one realizes that predation charges cannot be sustained. The price charged by firm I is higher than its total costs since firm I makes positive profits. On the other hand, if the downstream branch of the integrated firm was to operate separately then it would be making losses. The access price is determined by the pricing condition, $A = P - Ce$, and therefore the total costs of the disintegrated (hypothetical) downstream operator are $P + Ci - Ce$. The downstream profit per unit is $Ce - Ci$ which is negative given that firm E is relatively more efficient.[32] It may be argued that excessive pricing charges could be put forward, given the monopoly nature of (1.27). However, excessive pricing is very seldom used in the current antitrust practice and as a result it appears that there is room for price squeeze testing.

1.4.2 Remedies

This section of the paper analyses several possible remedies and their effects on social welfare. In what follows we shall concentrate on the case where there is foreclosure, that is the anticompetitive scenario.

[31] Welfare under (Bertrand pricing) entry is lower than under perfect competition (see Appendix 1.9.2). In the (Bertrand pricing) entry case, firm I enjoys market power which is illustrated from the fact that the access price is higher than the upstream costs. As a result the price set is higher than the social welfare maximising level.

[32] Note that technically, an equally efficient competitor test is not satisfied under Entry Bertrand pricing; however such a test would not be pursued by competition authorities since firm I is not active in the downstream market (in any case the effects of price squeeze testing also under Entry Bertrand pricing are examined in Appendix 1.9.4).

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1.4.2.1 Structural remedy

The divestment of the vertically integrated firm is one natural candidate for addressing the price squeeze identified above. However, as shown below, this does not improve the outcome for the consumers.

Lemma 1.2 *Under downstream Bertrand competition, imposing structural separation does not benefit consumers, however, social welfare may improve due to productive efficiency.*

Proof: Under this remedy, both the divested downstream branch of I, denoted I', and E have to pay firm I an access price, A. In the first stage, firm I sets an access price A to both I' and E. At stage 2, downstream firms compete in price.

Under the assumption that $Ce < Ci$ in the second stage of the game, only firm E stays active[33] and the price that it charges in this divestment scenario, denoted as P^d, is

$$P^d = A + Ci \tag{1.35}$$

This price, given the nature of the Bertrand competition in the downstream market, reflects the costs of the less efficient downstream competitor.

In the first stage of the game firm I sets the access charge, A, to maximise its profits, given equation (1.35). This yields

$$A^d = \frac{Z + V - Ci}{2} \tag{1.36}$$

The access charge is lower than under foreclosure, given in (1.15).[34] Substituting into equation (1.35) the downstream price is identical to the foreclosure case (equation (1.26))

$$P^d = \frac{Z + V + Ci}{2} \tag{1.37}$$

The structural remedy is still a monopoly profit maximization problem. Firm I's profit is identical to the foreclosure case (equation (1.28)). Furthermore, since the price and the quantity consumed remain unchanged the consumers are not better off (i.e. $S^d = S^{B,F}$). However, there is an additional profit, that of the entrant which arises because of its productive efficiency:

$$\Pi_E^d = \frac{(Ci - Ce)(Z - V - Ci)}{2} \tag{1.38}$$

[33] We consider the small cost asymmetries case since as shown in Appendix 1.9.4 for the relevant value parameters it is not profitable for the upstream monopolist to set A such that firms downstream have "large cost asymmetries" so that firm E can set a monopolist price.

[34] For the range of parameters for which condition (1.29) holds.

All in all, we observe that the social welfare is somewhere between the two cases described above.

$$W^{B,F} < W^d = W^{B,F} + (Ci - Ce)(Z - V - Ci) < W^{B,E} \tag{1.39}$$

The second inequality arises because of the higher price in the divestment case (causing greater allocative inefficiency).[35] The first inequality reflects the productive efficiency achieved in the divestment case. In terms of the graph above consumers enjoy area A, firm I has profits equal to area B and the entrant gets area F.

Therefore while the productive inefficiency of the foreclosure case disappears, the double marginalisation (monopoly upstream and Bertrand margin downstream) does not allow the final price to drop. In Appendix 1.9.4 price discrimination and non linear pricing are presented in the context of structural separation as ways to solve the double marginalisation problem.

1.4.2.2 Regulation

An alternative option for the regulator is to impose an appropriate access price to guarantee that E actually enters. Essentially the first stage of the game is not played since the regulator now chooses A. For example, the regulator could impose

$$A = V \text{ or any } A \in [V, V + Ci - Ce]$$

This would allow E to enter and serve the downstream market. Therefore, when the access price is appropriately regulated then firm I has no scope to foreclose entry. The downstream price is equal to $P = V + Ci$, given that for this range of A the entrant has lower total costs than the incumbent. Consumer surplus is equal to the level achieved in the entry case, S^E. The choice for A is an instrument to share the total profit. When $A = V$ then all the profits are appropriated by the entrant while when $A = V + Ci - Ce$ all profits accrue to the incumbent, as in the entry scenario. In terms of the graph above, consumer surplus is equal to $A + B + C$ whereas the profits to be shared is represented by area $F + G$. Under regulatory access pricing the social welfare is identical to the entry scenario. Consumers gain from lower price (which is now determined upstream from regulation and downstream

[35] Note that this inequality also illustrates that the structural separation outcome may be welfare detrimental when entry is the optimal outcome of the game in section 4.1. This arises since the downstream price under structural separation is higher. For a complete analysis of the structural divestment scenario see Appendix 1.9.4.

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from Bertrand competition) and productive efficiency is achieved given that firm E serves the market.

However, a regulatory intervention in terms of setting the access price may be problematic. For example, as Chone (2002) argues that it is very hard in practice to evaluate the access price appropriately as it is necessary for the regulatory authority to be able to calculate the upstream costs, V. He claims that this is harder to determine than the downstream costs of the two firms. The informational disadvantage for the regulator is greater given that in the downstream market there are two competitors, and therefore an additional source of information. Also, in V infrastructure costs are included which are hard to estimate in a multi-product environment. Instead it could be easier to estimate the incremental costs in the downstream market. Furthermore, regulation raises an expropriation issue and it affects the ex ante incentives of firms to invest (see for example Motta (2004)).

1.4.2.3 Price Squeeze tests

An alternative remedy is to impose a price squeeze test. Given the inconclusive discussion on the appropriate test format (see section 2.2) we generally assume a price squeeze format $P \geq A + \delta$ with δ being the minimum margin between the two prices chosen by the regulator or the competition authorities, i.e. $\delta \in [Ce, Ci]$.

Lemma 1.3 *Under Bertrand downstream competition, price squeeze testing improves consumer and social welfare. It also achieves a weakly superior outcome compared to structural separation.*

This test limits the strategy space for firm I. In the second stage of the game firm I has "costs" not necessarily equal to $V + Ci$ but the maximum between $(A + \delta, V + Ci)$.

Since δ is higher than Ce, firm E serves the market at price[36]

$$P = A + \delta \tag{1.40}$$

This happens since the "costs" of firm E are lower than those of the incumbent firm, namely $A + Ce < A + \delta$.

In this entry scenario, firm I maximizes its profit

$$max_A(A - V)(Z - A - \delta)$$

[36]It can be shown that it is not profitable to set A such that $A + \delta$ is smaller than $V + Ci$ when condition (1.29) holds. An analysis for all parameter range is exposed in Appendix 1.9.5 for $\delta = Ci$.

which yields

$$A^{ps} = \frac{Z + V - \delta}{2} \tag{1.41}$$

$$P^{ps} = \frac{Z + V + \delta}{2} \tag{1.42}$$

It is straightforward to show that this price is obtained when a firm enjoys a monopoly position with underlying costs $V + \delta$.

Concerning the effect of this policy to social welfare one should note that the social welfare is decreasing in delta. More specifically,

$$W^{ps} = \frac{(Z - V - \delta)^2}{4} + \frac{(\delta - Ce)(Z - V - \delta)}{2} + \frac{(Z - V - \delta)^2}{8} \tag{1.43}$$

$$\frac{\partial W^{ps}}{\partial \delta} < 0$$

When $\delta = Ci$, then the outcome is exactly the same as when the vertically integrated firm is divested. This means that there is a productivity gain, which accrues to the entrant, but there is no gain for consumers. As δ decreases the double marginalisation problem also decreases since firm E has lower market power.

When $\delta = Ce$ the entrant is making no profit. The price charged in the downstream market is identical to the price charged by a monopolist with underlying costs $V + Ce$. The social welfare is identical to the welfare in the case of a monopoly with costs $V + Ce$, namely

$$W^{ps=ce} = \frac{3(Z - V - Ce)}{8} \tag{1.44}$$

Since $Ce < Ci$ the profit margin "allowed" for firm E is lower which results in lower final price and therefore more output is produced than under divestment (with linear pricing and no price discrimination). The price squeeze obligation makes firm I's high access price credible. Therefore even if firm I's cost are lower than E's, the price squeeze test does not allow firm I to undercut firm E. Under this scenario we do not achieve the high social welfare results obtained under price regulation. It can be shown that that $W^{\delta=Ce} < W^{E}$ (see Appendix 1.9.3). All in all, we have

$$W^{B,F} < W^{d} = W^{ps=Ci} < W^{ps=Ce} < W^{B,E} = W^{reg}$$

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Practical implications concerning the price squeeze test Chone (2002) argues that the price squeeze test offers some further advantages. Its greatest advantage is on the practical side; namely, that calculating costs in the downstream market may be easier than the upstream costs of firm I. Also there is no need to calculate the internal prices charged by the integrated firm.

To abide with the price squeeze test, the incumbent firm would have either to decrease the access price, A or to increase the downstream price it charges, or both. Chone (2002) argues that pricing according to the price squeeze test is sometimes better suited than blind cost orientation since sometimes depriving the monopolist from reaping the benefits of their investment can have negative consequences in the long run, reducing the ability and incentives to innovate. Therefore policy makers shall also take into account how the monopoly position has been acquired as Motta and de Streel (2003) suggest.[37] The price squeeze test instead would let the monopolist receive its monopoly profit and at the same time the welfare outcome similar to a divestment would be at least achieved.

The above analysis only holds for the case where (total) foreclosure arises in section 4.1. Imposing a price squeeze test for the range of cost parameters for which only firm E serves the market would impose a too high price floor on the market (see Brunekreeft et all (2005)). An analysis of introducing an equally efficient test also for the price of the entrant leads to higher prices as illustrated in Appendix 1.9.5. However, it is highly unrealistic that antitrust authorities would require such a price squeeze obligation when the vertically integrated firm is not active downstream.

1.4.2.4 Nonlinear pricing

In this part we consider the implications of relaxing the assumption on the linearity of the access price. Suppose firm I charges firm E a franchise fee of the form $R + wq$, where $w = V$, i.e. the marginal cost of the upstream production, and R is the fixed part or the franchise fee. In this case the maximization problem of firm E yields

$$P^{nl} = \frac{Z + V + Ce}{2} \tag{1.45}$$

which is the same price as with a monopolist with downstream costs Ce. The profits of the entrant are

[37] For example if the upstream market is the only profitable level of production (because for example downstream competition is very strong) setting an upper limit to the access price might discourage investment in the only profitable level of production.

$$\Pi_E^{nl} = \frac{(Z - V - Ce)^2}{4} - R \tag{1.46}$$

If firm I has all the bargaining power then he can charge R to appropriate all the profits. Such profits for firm I are strictly higher than under foreclosure. However, firm I cannot commit that it will not undercut firm E in the downstream market in the second stage of the game. It has an incentive to sell in the downstream market since its marginal costs are $V + Ci$ which is below (1.45). Therefore if the incumbent cannot credibly commit the two part tariff does not solve the problem. The equilibrium price would remain $V + Ci$ (see Appendix 1.9.4 for the impact of non linear pricing in the structural remedy scenario).

1.4.2.5 Merger

An integrated structure whereby firm I and E are brought together yields strictly greater profits to firm I than the foreclosure scenario (note that firm E makes no profit in either scenario). Chicago school proponents may argue that firm I would prefer to merge with the rival rather than to inefficiently engage in price squeeze or other foreclosure strategies. In our setting we could assume that before the game described above begins, i.e. at stage 0, firm I can make a take it or leave it offer to the entrant to buy its technology. Indeed, given that we consider the case where firm I has an incentive to behave anti-competitively, firm I would have an incentive to buy out the entrant since the profit it gets in the merger case are higher

$$\Pi_I^m = \frac{(Z - V - Ce)^2}{4} > \Pi_I^{B,F} = \frac{(Z - V - Ci)^2}{4}$$

Given that the entrant is making zero profits (under both the entry and the foreclosure scenario), firm E would be willing to sell its technology even for a sellout price as low as zero. Furthermore, such a merger has positive effects for the society since consumer surplus is also increased, under inequality (1.29). This arise since the integrated structure would not have a commitment problem, would internalise double marginalisation and at the same time would exploit the productive efficiency of firm E.

On the other hand, social welfare does not always increase compared to the Entry Bertrand case (Bi) above; this arises since under Bi a much lower price is set which is likely to compensate for the lower profits of the firms (see Appendix 1.9.3). Furthermore, in a dynamic context such a zero sellout price merger scenario could have very adverse effects since if the entrants know that they will bought off for nothing they would simply not invest in more productive technologies.

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1.5 Quantity (Cournot) Competition

1.5.1 Quantity Competition Analysis

In this section we assume that the firms compete downstream in quantities and we explore whether they have similar incentives as in the Bertrand case.

The timing of the game is identical: in the first stage firm I chooses the access price and in the second stage the firms compete in quantities.

The second stage is a Cournot game with asymmetric costs; firm I faces costs $V + Ci$ and firm E $A + Ce$. Solving the game backwards, the second stage "standard" Cournot equilibrium quantities and price are:

$$q_I^C = \frac{Z - 2V - 2Ci + A + Ce}{3} \tag{1.47}$$

$$q_E^C = \frac{Z - 2A - 2Ce + V + Ci}{3} \tag{1.48}$$

$$P^C = \frac{Z + V + Ci + A + Ce}{3} \tag{1.49}$$

The equilibrium quantities suggest that there is a range of values of A that i) both firms can operate in the downstream market ii) firm I operates as a monopolist or iii) firm E operates as a monopolist. Therefore, a priori we have to compare three scenarios under which small cost asymmetries arise. When firm E operates as a monopolist we need to further consider a small and a large cost asymmetries scenario.

In the first stage of the game firm I maximizes its profit, which is given by the following Kuhn Tucker optimisation problem

$$max_A \Pi_I^C = (A - V)q_E + (P - V - Ci)q_I$$

$$\text{s.t. } q_I \geq 0, q_E \geq 0$$

Case A: Duopoly. When both constraints are not binding, which implies that both firms produce positive quantities, the optimal A and P (substituting equation (1.50) in (1.49)) are given by[38]

$$A^{C,D} = \frac{5Z + 5V - Ci - 4Ce}{10} \tag{1.50}$$

[38] The superscript stands for Cournot (C), Duopoly (D).

$$P^{C,D} = \frac{Z + V + Ci}{2} - \frac{Ci - Ce}{5} \tag{1.51}$$

The profits of firms I and E and social welfare are respectively (see Appendix 1.9.6)

$$\Pi_I^{C,D} = \frac{(Ci - Ce)^2}{5} + \frac{(Z - V - Ci)^2}{4} \tag{1.52}$$

$$\Pi_E^{C,D} = \frac{4(Ci - Ce)^2}{5} \tag{1.53}$$

$$W^{C,D} = \frac{3}{8}(Z - V - Ci)^2 + \frac{19}{50}(Ci - Ce)^2 + \frac{1}{10}(Ci - Ce)(Z - V - Ci) \tag{1.54}$$

Case Bi: Only Entry Cournot pricing. When the constraint on qi binds, i.e. when firm I produces a quantity equal to zero, through equation (1.47), the optimal A is

$$A^{C,E} = 2V + 2Ci - Z - Ce \tag{1.55}$$

$$P^{C,E} = V + Ci \tag{1.56}$$

The profits of the firms are given:

$$\Pi_I^{C,E} = (V + Ci - Z + Ci - Ce)(Z - V - Ci) \tag{1.57}$$

$$\Pi_E^{C,E} = (Z - V - Ci)(Z - V - Ci) \tag{1.58}$$

$$\Pi_{Total}^{C,E} = (Ci - Ce)(Z - V - Ci) \tag{1.59}$$

Note interestingly that these are the total profits also under Bertrand competition with entry (equation (1.16)). Similarly the price, consumer and social welfare are identical to the entry scenario under Bertrand (see equations (1.30)-(1.31)).

Case Bii: Only Entry monopoly pricing.

This scenario is requires

$$\begin{aligned} \max_A \Pi_I^{C,M} &= (A - V)(\frac{Z - A - Ce}{2}) \\ \text{s.t. } V + Ci &> \frac{Z + A + Ce}{2} \end{aligned}$$

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This leads to the same outcome under Entry monopoly pricing under Bertrand (equations (1.19)–(1.20)) and it is optimal when:

$$(Z - V - Ci) < \frac{1}{3}(Ci - Ce) \tag{1.60}$$

Case C: Foreclosure. When the constraint on qe binds then equation (1.48) determines the access price and the market outcome coincides with the foreclosure case of the Bertrand game (equations (1.26)- (1.28))

Firm I produces as a monopolist and has profits

$$\Pi_I^{C,F} = \frac{(Z - V - Ci)^2}{4} \tag{1.61}$$

These results provide interesting insights.

Proposition 1.2 *Under downstream Cournot competition i) firm E is never optimally totally foreclosed from the market ii) both firms are active in the downstream market when* $(Z - V - Ci) > \frac{2}{5}(Ci - Ce)$

Proof:

Comparing (1.52) and (1.61):

$$\Pi_I^{C,D} = \frac{(Ci - Ce)^2}{5} + \frac{(Z - V - Ci)^2}{4} > \Pi_I^{C,F} = \frac{(Z - V - Ci)^2}{4}$$

Hence, total foreclosure cannot arise as a profit maximizing outcome. Firm I receives, when both firms compete, profits which are strictly greater than when firm I produces as a monopolist. This implies that firm I will never have the incentive to totally foreclose entry under Cournot, as long as the new entrant is strictly more efficient than firm I. This proves part i) of the Proposition

By comparing (1.52) and (1.57) we conclude that Case A (duopoly) is profit maximising when:

$$\Pi_I^{C,D} = \frac{(Ci - Ce)^2}{5} + \frac{(Z - V - Ci)^2}{4} > \Pi_I^{C,E} = (V + Ci - Z + Ci - Ce)(Z - V - Ci)$$

$$\iff (Z - V - Ci) > \frac{2}{5}(Ci - Ce) \tag{1.62}$$

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[39]which also proves part ii) of the Proposition. This implies that both firms would produce as long as demand is relatively large, upstream costs are relatively small or the downstream cost difference between the two firms is relatively small.

Conversely, only firm E will be active in the downstream market when

$$(Z - V - Ci) \leq \frac{2}{5}(Ci - Ce) \tag{1.63}$$

Welfare analysis Again here we compare only the cases which determine whether duopoly or only entry will take place (i.e. Case A and Bi). Comparing the optimal, from firm I's perspective, price in the duopoly and only entry Cournot pricing scenarios (Cases A and Bi) we observe that the duopoly price, (1.51), is higher when duopoly is maximising firm I's profits and lower when the entrant is the only firm operating downstream, i.e. the highest price is always set.[40] Similarly, when inequality (1.62) holds welfare is higher when only firm E is active downstream even though duopoly arises as an equilibrium outcome while when firm E is the only producer (i.e. inequality (1.62) does not hold), social welfare is higher under duopoly. Therefore, firm I's choice leads to lower social welfare than the other case would lead to (see Appendix 1.9.7). This arises because the adverse effect on pricing (and as a result on consumer welfare) dominates the increase in firm I's profits.

Nature of price squeeze As shown in Proposition 1.2, under Cournot competition total foreclosure does not arise. Therefore, the reasonably efficient competitor test, $P - A \leq Ce$, is never violated, in other words such a price test would be superfluous. However, a price squeeze arises when the equally efficient competitor test is applied in the case of duopoly.[41] This means that if the incumbent's downstream affiliate were to face the same access price as the entrant faces it would make losses. This leads to partial foreclosure (raising rival's costs).

The most obvious scenario for price squeeze allegations is case A where both firms are active downstream but the price structure of the access price and the downstream price are such that gives rise to $P - A \leq Ci$. Therefore,

Lemma 1.4 *Under downstream Cournot competition, partial foreclosure arises*

[39]Note that this condition bears some similarities with equation (16) of the Bertrand competition analysis.
[40]See Appendix 1.9.7
[41]Also an equally competitor test is not passed under Bi as under Bertrand competition. However, such a price squeeze test where firm I is not active in the downstream market is not enforced in current antitrust practice.

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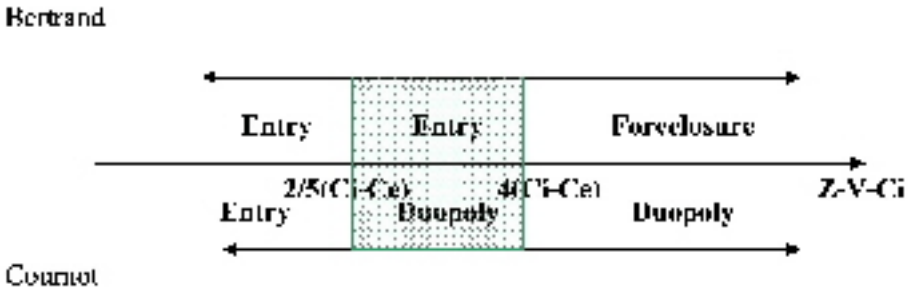
1.5.2 Comparison with Bertrand competition

Comparing the results of the Bertrand and the Cournot game, we observe two main differences. First, total foreclosure never arises under Cournot while it may arise under Bertrand when the cost difference between the two firms downstream is not very significant (see Proposition 1.1 and 1.2 and diagram below). Secondly, for a greater range of parameters it is likely that firm E is the only downstream player under Bertrand competition. Firm E is the only active firm under Cournot when inequality (1.62) holds. Comparing this with inequality (1.29), we observe that it is a more stringent condition and therefore less likely to arise (i.e. in the coloured area below under Cournot both firms are active while under Bertrand only firm E). The intuition behind both observations relates to the nature of Cournot competition.



The second observation arises because firm E under Cournot enjoys greater market power than under Bertrand. This is reflected from the fact that firm I can only capture part of the total profits in the "only entry" case under Cournot while in Bertrand firm I extracts all profits through the access price. As seen by equations (1.16) and (1.57) the profits of firm I are lower under Cournot competition than under Bertrand for relatively large cost differences (which implies that only firm E operates). However, one notes that the combined profits of the two firms are identical under Cournot and Bertrand competition (equations (1.10) and (1.59)). Furthermore, the final price when only firm E operates (and there is Bertrand or Cournot pricing) is the same under both types of competition; however, the access price is set at a lower level under Cournot competition (by comparing equations (1.15) and (1.55)). These elements reflect the market power of firm E under Cournot when there are relatively large cost differences which leads to a different profit sharing among the firms. As a result of its lower profits under Cournot, firm I would prefer to produce downstream for a greater parameter range under Cournot than under Bertrand. Furthermore, under Cournot, Entry

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monopoly pricing is more likely to arise (indeed it always arises when

$$(Z - V - Ci) < \frac{1}{3}(Ci - Ce) \tag{1.64}$$

since under Bertrand firm I enjoys higher profits when there are small cost asymmetries (and therefore Entry Bertrand pricing). This is welfare detrimental.

The observation on the foreclosure incentives of the incumbent can be explained in terms of the different magnitudes of the effect of the reduction of demand for the upstream input, and the extra volumes that the incumbent can sell downstream. In Bertrand when firm I forecloses the market, it serves the whole market whereas when it allows entry its downstream operations remain inactive. At the same time since there is Bertrand competition the profits to be made by the rival firm downstream would be expected to be relatively small in the scenario where the firms' costs do not vary significantly, since it can only gain the difference between these costs.[42] This reduces the scope to extract revenues from the access price, A, and therefore the incentive to foreclose is much stronger.

The interesting part of the Cournot case is that there is an intermediate step where both firms could serve the market. The incumbent by reducing the price slightly below the monopoly (foreclosure) level, and loosing a mere $\frac{(Ci-Ce)}{5}$ on the inframarginal units,[43] can get access to a larger market through firm E. More specifically it could gain $\frac{2(Ci-Ce)}{5}$ units that can be produced by firm E yielding profits per unit $(A - V)$ and would only have to give up $\frac{(Ci-Ce)}{5}$ units of its own production. Computing the value of these units for firm I, one observes that the value of the extra units produced by firm E is larger than the value that firm I could contribute on its own. The intuition is that the incumbent is able to exploit the productive efficiency of the entrant without having to sacrifice much of its own quantity produced. This can be also seen from the evolution of access prices when cost differences are relatively small (compare equations ((1.15)) and (1.50)). As the two firms become closer in terms of their cost structure (Ci decreases), firm I can increase the access price under Cournot duopoly while under Bertrand competition the access price would have to be reduced to ensure that firm E can operate effectively. Furthermore, the access price that firm I can set in a Cournot duopoly is higher than the price that firm I can set when only firm E serves the market under Bertrand competition (comparing (1.15) with (1.50)). A higher access price under Bertrand would not be credible given the strength of downstream competition; in other words firm E would not accept a higher price since firm I

[42] On the other hand, the profits under the entry case can be higher than in the foreclosure case since the form of Bertrand competition obliges firm E to produce a very large quantity relative to the monopoly level produced by the incumbent in the foreclosure scenario and/or because the entrant is very efficient relative to the incumbent, i.e when $(Ci - Ce)$ is very large.

[43] Reflecting the change in price in both cases (see equations (45) and (13))

cannot commit not to compete in the downstream market once it has granted access to firm E. However, since downstream competition is weaker under Cournot competition, firm I is able to set a higher access price and thereby exploit firm E's productive efficiency.

This result bears strong similarities with the commitment problem described by Hart and Tirole (1990). An important insight is that the upstream firm faces a commitment problem; the loss of monopoly power associated with the commitment problem is more severe the more competitive the downstream segment is. In our setting having the downstream operations the integrated firm cannot benefit from the greater efficiency of the entrant unless it sets an access price that ensures the viability of its business when competing with the downstream operations of the vertically integrated firm. Under downstream Bertrand competition with small cost asymmetries therefore there is a stronger incentive to foreclose since firm E would only enter when the access price is relatively low (strong commitment problem). On the other hand in Cournot a relatively higher access price can be set given that competition is weaker (no big commitment problem) and therefore it is not optimal for the incumbent firm to exclude an efficient competitor.

1.5.3 Cournot with n firms downstream

We extend the above Cournot model by introducing n firms in the downstream market that compete with the downstream affiliate of the vertically integrated firm. We assume that all the potential entrants, E1, ..., En have the same marginal cost, Ce.

Total foreclosure does not arise in a generalised game with n downstream firms competing in quantity. Firm I, as in the duopoly case above always prefers these firms to enter. As long as a condition on costs holds, namely that

$$Z - V - Ci \geq \frac{2n}{n+4}(Ci - Ce) \tag{1.65}$$

firm I also produces in the downstream market alongside these firms. When the sign of the inequality is reversed then firm I prefers to let only the entrants to supply the downstream market. Therefore Proposition 1.2 can be generalised with more firms competing in the downstream market. One notices that as the number of downstream firms increases (and therefore the degree of competition increases) it becomes harder to satisfy inequality (1.65); this implies that the more the downstream entrants the more likely it is that the vertically integrated firm would not produce downstream. Contrasting conditions (1.29), (1.62), (1.65) we observe that the higher the degree of competition (going from Cournot with one downstream competitor to Cournot with n competitors to Bertrand competition) the less likely

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it is that firm I produces in the downstream market. The stronger the downstream competition, the smaller the market power of firm E and the share of the revenues that accrues to the entrant. As a result firm I enjoys higher revenues the stronger the downstream competition when firm E is active and hence "only entry" is more likely for a greater range of parameters.[44]

Interestingly, one can also demonstrate that even though foreclosure is never optimal for the incumbent, price squeeze always arises when considering the test format $P - A \leq Ci$.

Proposition 1.3 *Under downstream Cournot competition, total foreclosure does not arise in a generalised game with n downstream firms. Firm I will be active when* $Z - V - Ci \geq \frac{2n}{n+4}(Ci - Ce)$ *and partial foreclosure arises.*

Proof: generalisation of the duopoly.

1.5.4 Remedies

In this section the welfare effects of several remedies are analysed. We consider the cases where there is structural divestment of the vertically integrated firm, regulation of the access price and price squeeze test.

1.5.4.1 Structural Remedy

We solve the same game taking into account the divestment of the vertically integrated firm. This yields two broad classes of outcomes: i) where both firms operate in the downstream market (where the upstream monopolist would set A such that small cost asymmetries arise) and ii) where only the entrant serves the downstream market.

Lemma 1.5 *Under downstream Cournot competition, structural divestment leads to duopoly when* $(Z - V - Ci) > 3(Ci - Ce)$. *Otherwise only firm E is active.*

Proof: The second stage of the game is an asymmetric costs Cournot game.

In the first stage, the Kuhn Tucker maximisation problem of firm I is given by:

[44] Note that as $n \to \infty$ the limit of equation (1.65) is $Z - V - Ci \geq 2(Ci - Ce)$. This is not identical to the condition under Bertrand since there is an additional effect; under Cournot competition firm I enjoys higher profits under n-opoly (i.e when all firms, including firm I, are active downstream) than when it operates as a downstream monopolist (which is the alternative under Bertrand competition). As a result firm I remains inactive for a lower range of parameters under Cournot with n firms than under Bertrand competition.

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$$max_A \Pi_I^{Cd} = (A - V)Q$$

$$\text{s.t. } q_{I'} \geq 0, q_E \geq 0$$

The second inequality is superfluous and hence the results for the two cases are given below:

Case A: Duopoly can arise only when

$$q_{I'} > 0 \Leftrightarrow (Z - V - Ci) > \frac{5}{2}(Ci - Ce)$$

The access and downstream prices as well as the profits and social welfare are given by:

$$A^{Cd,D} = \frac{2Z + 2V - Ci - Ce}{4} \tag{1.66}$$

$$P^{Cd,D} = \frac{4Z + 2V + Ci + Ce}{6} \tag{1.67}$$

$$\Pi_I^{Cd,D} = \frac{1}{24}(2z - Ci - Ce - 2V)^2 \tag{1.68}$$

$$\Pi_{I'}^{Cd,D} = (\frac{1}{6}(Z - V - Ci) - \frac{5}{12}(Ci - Ce))^2 \tag{1.69}$$

$$\Pi_E^{Cd,D} = (\frac{1}{6}(Z - V - Ci) + \frac{7}{12}(Ci - Ce))^2 \tag{1.70}$$

$$W^{Cd,D} = \frac{10}{36}(Z - V - Ci)^2 + \frac{20}{72}(Z - V - Ci)(Ci - Ce) + \frac{82}{144}(Ci - Ce)^2 \tag{1.71}$$

Case Bi: Only Firm E Cournot pricing (i.e. firm E producing with small cost asymmetries) can only arise when $(Z - V - Ci) < \frac{5}{2}(Ci - Ce)$

The access and downstream prices as well as the profits and social welfare are given by:

$$A^{Cd,E} = Z + Ce - 2Ci \tag{1.72}$$

$$P^{Cd,E} = Z - Ci + Ce \tag{1.73}$$

$$\Pi_I^{Cd,E} = (Z - V + Ce - 2Ci)(Ci - Ce) \tag{1.74}$$

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$$\Pi_E^{Cd,E} = (Ci - Ce)^2 \tag{1.75}$$

$$W^{Cd,E} = (Z - V - Ci)(Ci - Ce) + \frac{1}{2}(Ci - Ce)^2 \tag{1.76}$$

Comparing Proposition 1.2 and Lemma 1.5, we note that firm E is more likely to be the sole producer in the downstream market in the divestment case than under vertical integration. The intuition is that in this case of divestment the downstream firms have more "asymmetric" costs than under vertical integration (since now both downstream firms have to pay the same access price). This implies also that the condition for firm E producing alone (which is determined by whether it is profitable for firm I' to produce) is satisfied for a wider range of parameters.

Case Bii: Only Firm E Monopoly pricing (i.e. firm E producing with large cost asymmetries) can only arise when $(Z - V - Ci) < 3(Ci - Ce)$

This case leads to access and downstream price standard under firm E monopoly pricing given by equations (1.19)-(1.20).

Also

$$\Pi_I^{C,M} = \frac{(Z - V - Ce)^2}{8} \tag{1.77}$$

$$\Pi_E^{C,M} = \frac{(Z - V - Ce)^2}{16} \tag{1.78}$$

$$W^{C,M} = \frac{7(Z - V - Ce)^2}{32} \tag{1.79}$$

Interestingly this scenario can now arise for a larger parameter range. this arises since the condition in the maximisation problem is that the now independent downstream operations have higher costs than the monopoly price of the entrant. This can arise for a larger set of parameter values since $A + Ci > V + Ci$.

Comparing the profits of firm I under these three cases we observe that (1.77) is higher than both (1.68) and (1.74). Therefore, we obtain Lemma 1.5 that structural divestment leads to duopoly when $(Z - V - Ci) > 3(Ci - Ce)$.

Lemma 1.6 *Under downstream Cournot competition, welfare (weakly) decreases under structural divestment.*

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Proof: Comparing the welfare under vertical integration and structural separation we distinguish three cases:

Case A: When $(Z - V - Ci) > 3(Ci - Ce)$ a duopoly arises irrespective of whether firm I is vertically integrated or not. In this situation applying the remedy yields lower welfare (equation (1.71) vs (1.54)). The downstream prices are higher in the divestment case (equations (1.67) vs. (1.51)) reflecting the double marginalisation problem in the divestment scenario; however, the access price is lower under the structural remedy (equation (1.66) compared to (1.50)) which reflects the fact that firm I in the vertically integrated scenario sets a higher access price to exploit the efficiency of the entrant for the last units of output produced. Under structural remedy the adverse effect on pricing dominates the productive efficiency since the quantity produced by E firm does not increase significantly to outweigh the negative effect on price (allocative inefficiency).

Case B: When $3(Ci-Ce) \geq (Z-V-Ci) \geq \frac{1}{3}(Ci-Ce)$ under structural divestment there is "perfect" double marginalisation (as only Firm E is active setting downstream monopoly pricing). Under vertical integration instead, there is duopoly when $(Z-V-Ci) \geq \frac{2}{5}(Ci-Ce)$ and for $\frac{2}{5}(Ci - Ce) \geq (Z - V - Ci) \geq \frac{1}{3}(Ci - Ce)$ firm E is the only firm producing in the downstream market at a much lower downstream price (determined by the Cournot equilibrium). For this range of parameters vertical divestment always leads to "perfect" double marginalisation and therefore social welfare decreases.

Case C: When $(Z - V - Ci) < \frac{1}{3}(Ci - Ce)$ there is no effect.

Therefore we observe that welfare always decreases. Note however, that the relevant parameter space is when $(Z - V - Ci) \geq \frac{2}{5}(Ci - Ce)$ (i.e. case A and part of Case B) since only in these cases firm I is active downstream and therefore competition authorities may take action against a vertically integrated firm.

One other important observation is that both the profits of firm I and the access price are (weakly) lower under vertical separation than under vertical integration in all three cases (weakly for case C). This demonstrates that the commitment problem that firm I faces under vertical separation is greater than under vertical integration i.e. vertical integration is a way to restore part of the monopoly power of the upstream monopolist.

1.5.4.2 Regulation

We analyse the welfare implications of regulating the access price. As a benchmark we investigate the effects of setting $A = V$.

The second stage of the game is an asymmetric costs Cournot game while the first stage is deterministic ($A = V$). We distinguish two cases; one where there is duopoly downstream (small cost asymmetry) and one where only firm E operates (large cost asymmetry). Firm I upstream makes no profits since $A = V$.

Case A: Duopoly. Under duopoly price and social welfare are

$$P^{Cr,D} = \frac{Z + 2V + Ci + Ce}{3} \tag{1.80}$$

$$W^{Creg,D} = \frac{8}{18}(Z - V - Ci)^2 + \frac{8}{18}(Z - V - Ci)(Ci - Ce) + \frac{11}{18}(Ci - Ce)^2 \tag{1.81}$$

Firm I is active in the market when:

$$(Z - V - Ci) > (Ci - Ce) \tag{1.82}$$

Comparing this inequality with Proposition 1.2, one observes that firm E is the only firm active downstream for a higher range of parameters under regulation. This arises since firm I loses its upstream monopoly power due to the access price regulation. As a result it cannot increase the cost structure of firm E and therefore a large cost asymmetry (and therefore firm E operating as a monopolist downstream) is more likely to arise.

Case B: Only Firm E Monopoly pricing. Under entry firm E receives monopoly profits and therefore price and welfare are given by:

$$P^{Creg,E} = \frac{Z + V + Ce}{2} \tag{1.83}$$

$$W^{Creg,E} = \frac{3(Z - V - Ce)}{8} \tag{1.84}$$

Lemma 1.7 *Under downstream Cournot competition, welfare increases under marginal cost regulation*

Case A: When $(Z - V - Ci) > (Ci - Ce)$ there is a duopoly downstream under both scenarios. Social welfare, ((1.81) vs (1.54)), is higher under regulation. This arises since the access price is set by regulation i.e. firm I cannot use A to extract revenues from firm E. Also, firm E produces a higher quantity and enjoys higher profits. The final price, (1.80), is lower under regulation and social welfare increases (both productive and allocative efficiency).

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Case B: $(Ci - Ce) > (Z - V - Ci) > \frac{2}{5}(Ci - Ce)$ under regulation only firm E operates downstream whereas with no regulation both firms operate. Also this scenario, price, (1.83), is lower under regulation and welfare improves ((1.84) compared to (1.54)).

Case C: $(Z - V - Ci) < \frac{2}{5}(Ci - Ce)$ under both scenarios only firm E produces downstream. Price is lower under regulation and welfare improves. There is no mark up on the upstream market and therefore double marginalisation is avoided.

1.5.4.3 Price Squeeze

The third remedy we consider is the effect of introducing an equally efficient competitor price squeeze test: $P - A \geq Ci$. As it is clear from the results in the standard Cournot game introducing a test of the form: $P - A \geq Ce$ has no impact since total foreclosure is never optimal for the vertically integrated firm (see Proposition 1.2).

Lemma 1.8 *Under downstream Cournot competition, an equally efficient competitor price squeeze test leads to duopoly when* $(Z - V - Ci) > 3(Ci - Ce)$ *and may lead to duopoly when* $3(Ci - Ce) \geq (Z - V - Ci) \geq \frac{2}{5}(Ci - Ce)$. *Otherwise, only firm E is active.*

Proof: The effect of introducing an equally efficient competitor test is to limit the strategy space for firm I. In the second stage of the game it does not necessarily have costs $V + Ci$ but the maximum of $(V + Ci,\ A + Ci)$.

In the first stage, firm I maximises the following Kuhn Tucker problem:

$$max_A \Pi_I^{Cps} = (P - V - Ci)qi + (A - V)qe$$

$$\text{s.t. } q_{I'} \geq 0, P - A \geq 0$$

We distinguish 2 cases:

Case A: Duopoly may arise when $(Z - V - Ci) > \frac{5}{2}(Ci - Ce)$. Price and access price are given by:

$$P^{Cps} = \frac{3Z + 2V + 2Ci}{5} \tag{1.85}$$

$$A^{Cps} = \frac{4Z + 6V + Ci - 5Ce}{10} \tag{1.86}$$

$$W^{Cps} = \frac{8}{25}(Z - V - Ci)^2 + \frac{1}{2}(Ci - Ce)^2 + \frac{1}{5}(Ci - Ce)(Z - V - Ci) \tag{1.87}$$

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Note that the access and downstream price under an equally efficient test with duopoly are not the same as with the structural remedy. This contrasts with the Bertrand analysis since under Cournot and an equally efficient test firm I still runs downstream operations, while as shown in 4.2.3, it is not active in the downstream market under Bertrand competition.

Case B: Only Firm E Monopoly pricing may arise when $(Z-V-Ci) \leq 3(Ci-Ce)$.

This scenario is identical to structural separation; price, access price, profits and welfare are provided in equations (1.19), (1.20), (1.77), (1.78) and (1.79).

Comparing the profits of firm I in case A and B we observe that it depends on the range parameter whether firm I would be better off under duopoly or under only firm E acting as monopolist when $3(Ci-Ce) \geq (Z-V-Ci) \geq \frac{2}{5}(Ci-Ce)$

Comparing Lemma 1.8 with Proposition 1.2 we observe that duopoly is less likely to arise under price squeeze testing. This occurs since the price squeeze testing limits the profits that firm I can make through its own downstream operations and therefore it would prefer for a larger range of parameters to allow firm E to operate as a downstream monopolist.

Lemma 1.9 *Under downstream Cournot competition, when an equally efficient competitor test is introduced welfare may improve when* $(Z-V-Ci) > \frac{5}{2}(Ci-Ce)$

Case A: When $(Z-V-Ci) > \frac{5}{2}(Ci-Ce)$ a duopoly arises under vertical integration and under price squeeze duopoly always arises when $(Z-V-Ci) \geq 3(Ci-Ce)$ and may arise when $3(Ci-Ce) \geq (Z-V-Ci) \geq \frac{2}{5}(Ci-Ce)$.

Price squeeze testing limits the pricing policy that firm I can follow through its own downstream operations by requiring a specific margin. This leads to higher final price under price squeeze (1.85) compared to the vertical integration outcome (1.51). Furthermore, the access price ((1.86) is lower compared to the vertical integration duopoly (1.50)).

On the other hand, firm E produces more under an equally efficient competitor price squeeze test. By increasing the "effective downstream" costs of firm I, the price squeeze test reduces the competitive constraint that firm I places on firm E. This productive efficiency effect may dominate the adverse effect on consumers (higher final price) and social welfare may improve.

Note that the case considered here for price squeeze requires that a significant margin is allowed to the entrant which therefore leads to "unnecessarily" high prices. A test which requires firm I to ensure a lower margin $\delta = Ce + \varepsilon$ is likely to lead to more beneficial results (see also section 4.2.3. for a comparison between price squeeze testing with $\delta = Ce$ vs $\delta = Ci$).

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Comparing price squeeze and structural separation one observes that both the final price and the access price is higher under structural divestment than under price squeeze is equation. As a result, welfare under structural divestment is lower than under price squeeze testing (adverse effect under structural remedy while possible welfare improvement under an equally efficient competitor test).

Case B: When $\frac{5}{2}(Ci - Ce) \geq (Z - V - Ci) \geq \frac{1}{3}(Ci - Ce)$. Welfare may increase if the optimal outcome under price squeeze is a duopoly (only feasible as long as $(Z - V - Ci) > \frac{5}{2}(Ci - Ce)$) When only firm E is active under price squeeze welfare decreases due to the double marginalisation.

Case C: When $(Z - V - Ci) < \frac{1}{3}(Ci - Ce)$ there is no effect.

Note however, that the relevant parameter space is when $(Z - V - Ci) \geq \frac{2}{5}(Ci - Ce)$ (i.e. case A and part of Case B) since only in these cases firm I is active downstream and therefore competition authorities may take action against a vertically integrated firm. Also one notes that firm I is made worse off through the introduction of the price squeeze test. Its profits are compromised by its inability to compete in the downstream market.

1.6 Differentiated products

1.6.1 Price Competition Analysis

In this part of the paper we extend the Bertrand analysis considering a linear demand model of differentiated goods, following Singh and Vives (1984). Compared to the homogeneous good analysis above, one would expect foreclosure incentives to substantially decrease. We examine whether total foreclosure can still arise and under which conditions as an equilibrium result and whether price squeeze testing may improve welfare.

On the demand side, we assume the following functional form for the utility function:

$$U(q_I, q_E) = \alpha q_I + \alpha q_E - \frac{1}{2}(\beta q_I^2 + \beta q_E + 2\gamma q_I q_E) \tag{1.88}$$

$$\text{with } \alpha \geq 0, \beta \geq 0, \beta \geq |\gamma|$$

The parameter γ represents the level of differentiation between the two products. When it is equal to zero then the two products are independent (or maximally differentiated). When $\gamma > 0$ then the two products are substitutes since consuming the goods together increases the utility of the agent. For $\gamma \to \beta$ the two goods become perfect substitutes. When $\gamma < 0$ the

products are complements. In what follows we restrict our analysis to substitute products.[45] Furthermore, for simplicity we assume that parameters α, β are equal to one and therefore the following linear indirect demand functions are obtained:

$$p_I = 1 - q_I - \gamma q_E \tag{1.89}$$

$$p_E = 1 - q_E - \gamma q_I \tag{1.90}$$

with $\gamma \in [0, 1)$. $\gamma \to 1$ implies that the goods are perfect substitutes while when $\gamma = 0$ the downstream products are independent.

Inverting the system we get the direct demand functions:

$$q_I = \frac{(1-\gamma)}{1-\gamma^2} - \frac{p_I}{1-\gamma^2} + \frac{\gamma p_E}{1-\gamma^2} \tag{1.91}$$

$$q_E = \frac{(1-\gamma)}{1-\gamma^2} - \frac{p_E}{1-\gamma^2} + \frac{\gamma p_I}{1-\gamma^2} \tag{1.92}$$

On the supply side, we consider the same market structure with a vertically integrated firm and a downstream market competitor. For simplicity we assume that the costs of the upstream market are equal to zero; further we assume that firm E, the more efficient firm, has zero downstream costs. Hence, $V = Ce = 0$. We denote the downstream costs of the vertically integrated firm by C, which reflects the downstream cost difference between firms I and E.

The timing of the game is the same and in the second stage firms compete in prices.

Proposition 1.4 *Under Singh and Vives model of differentiated products and downstream Bertrand competition: i) duopoly is the most likely outcome ii) total foreclosure arises when the products are highly substitutable and the cost difference is relatively small iii) firm E produces as a downstream monopolist when the products are relatively close substitutes and the cost difference significant.*

Proof: In the second stage of the game the equilibrium quantities and price of the competing firms are given below:

$$q_I = \frac{2 - \gamma - \gamma^2 + A\gamma + C(\gamma^2 - 2)}{4 - 5\gamma^2 + \gamma^4} \tag{1.93}$$

[45] The results can be extended for complement products. However, foreclosure would never arise if the two downstream products are complements and therefore such a scenario is not of interest for this paper.

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$$q_E = \frac{2 - \gamma - \gamma^2 + C\gamma + A(\gamma^2 - 2)}{4 - 5\gamma^2 + \gamma^4} \tag{1.94}$$

$$p_I = \frac{2 - \gamma - \gamma^2 + 2C + A\gamma}{4 - \gamma^2} \tag{1.95}$$

$$p_E = \frac{2 - \gamma - \gamma^2 + 2A + C\gamma}{4 - \gamma^2} \tag{1.96}$$

In the first stage of the game firm I maximises the following Kuhn Tucker problem:

$$max_A \Pi_I = (P - C)q_I + Aq_E$$

$$\text{s.t. } q_I \geq 0, q_E \geq 0.$$

The two quantity constraints imply a range of values for A so that both firms are active downstream.[46]

We distinguish the following cases:

Case A: Duopoly

The optimal access price is given by

$$A^{D,D} = \frac{8 - 8\gamma^2 - \gamma^3 + \gamma^4 + c\gamma^3}{2\gamma^4 + 16 - 14\gamma^2} \tag{1.97}$$

This is optimal only when the following two conditions hold

$$(32 - 32C) - 8\gamma - \gamma^2(44 - 44C) + 6\gamma^3 + \gamma^4(17 - 17C) - \gamma^5 - \gamma^6(2 - 2C) > 0 \tag{1.98}$$

$$16 - \gamma(16 - 16C) - 20\gamma^2 + \gamma^3(16 - 16C) + 8\gamma^4 - \gamma^5(3 - 3C) - \gamma^6. \geq 0 \tag{1.99}$$

Case Bi: Only firm E Bertrand pricing.

The optimal access price is

[46] Combining the two constraints we obtain:
$(4 - 4C) - \gamma^2(5 - 5C) + \gamma^4(1 - C) \geq 0$
Note that for the range of values of γ relevant here this expression is always satisfied.

$$A^{D,E} = 1 + \frac{(1-C)(\gamma^2-2)}{\gamma} \tag{1.100}$$

and it is optimal to set such an access price when

$$(32-32C) - 8\gamma - \gamma^2(44-44C) + 6\gamma^3 + \gamma^4(17-17C) - \gamma^5 - \gamma^6(2-2C) \leq 0 \tag{1.101}$$

$$(4-4C) - 5\gamma^2 + 5\gamma^2 C + \gamma^4(1-C) \geq 0 \tag{1.102}$$

One would expect this case to arise when the products are close substitutes and the costs of the incumbent are relatively large.

Case Bii: Only firm E Monopoly pricing.

This scenario is identical to the homogenous Bertrand case. Therefore substituting for $V = Ce = 0$ we obtain:

$$A^{BD,M} = \frac{1}{2} \tag{1.103}$$

$$P^{BD,M} = \frac{3}{4} \tag{1.104}$$

$$\Pi_I^{BD,M} = \frac{1}{8} \tag{1.105}$$

$$W^{BD,M} = \frac{7}{32} \tag{1.106}$$

This scenario arises when firm E has a sufficient cost advantage which ensures that firm I cannot undercut the monopoly pricing of firm E. When $\gamma = 0$, both firms are active downstream and set monopoly pricing since they are monopolies on independent segments of the market. Similarly the lower the γ the more likely it is that both firms are active downstream. In the limit, for $\gamma \to 1$, firm E may set monopoly pricing downstream as long as the efficiency gap between the two firms is sufficiently high, namely $C > p^m = \frac{3}{4}$ (see also Zanchettin (2006) who considers an asymmetric costs Singh and Vives model). Firm I will be unable to undercut firm E's monopoly pricing (1.104) for the combination of C and γ that make equation (1.91) is set equal to zero. The minimum price that firm I can set equals its marginal costs, C.

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$$q_I = 1 - \gamma - C + \gamma\frac{3}{4} \leq 0 \tag{1.107}$$

$$\Leftrightarrow C \geq -\frac{1}{4}\gamma + 1 \tag{1.108}$$

Case C: Foreclosure, only firm I producing
The optimal access price is

$$A^{D,F} = \frac{2 - \gamma - \gamma^2 + C\gamma}{2 - \gamma^2} \tag{1.109}$$

This may arise when

$$16 - \gamma(16 - 16C) - 20\gamma^2 + \gamma^3(16 - 16C) + 8\gamma^4 - \gamma^5(3 - 3C) - \gamma^6 < 0 \tag{1.110}$$

$$(4 - 4C) - 5\gamma^2 + 5\gamma^2 C + \gamma^4(1 - C) > 0 \tag{1.111}$$

One would expect foreclosure to arise when the products are highly substitutable and when the costs of the incumbent are relatively low.

The diagram below graphs these conditions. The x-axis represents the degree of differentiation (γ) while the y-axis represents the cost difference (C). We distinguish three areas. The white area represents the duopoly outcome. If C and γ are uniformly drawn then duopoly is the most likely outcome. It is interesting to note that if the goods are independent (i.e. $\gamma = 0$) duopoly is the only plausible outcome. As competition becomes stronger (i.e. γ increases) the productive efficiency of firm E becomes more relevant and drives firm I out of the downstream market. As a result, as γ increases it becomes more likely that firm E is the only active firm downstream. This arises as long as the cost difference is significant. The higher the degree of differentiation the lower the cost difference needs to be for this scenario to arise. The upper shaded area represents the parameter space in which firm E is the only active downstream firm. We further distinguish two areas. Above the downwards sloping straight line which represents condition (1.108) case Bii arises, and "perfect" double marginalisation arises. In this area, firm E enjoys high market power since its cost efficiency compared to firm I is very significant. Between the downwards sloping line and above the concave line case Bi arises. In this area firm E is again the only downstream active firm, however, its cost advantage is not sufficient to allow it to set monopoly pricing.

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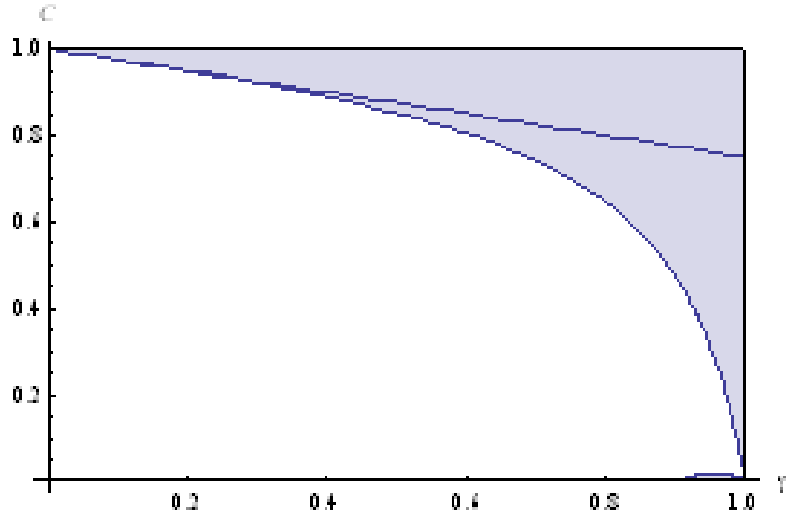
The rent extraction of firm E's efficiency of course is limited by the commitment problem that firm I faces, as discussed in detail in the homogeneous product cases. When the downstream products are highly substitutable, the access price that firm I can set is relatively small. This has a negative impact on firm I's profits and therefore firm I might prefer to (totally) foreclose entry when γ is relatively large. Foreclosure arises only for a very small cost difference (small values of C); for larger cost difference firm I would benefit more from the productive efficiency of firm E. Hence, foreclosure arises only in the small shaded area in the bottom right of the diagram.



Nature of price squeeze. In a model with differentiated products with downstream price competition, foreclosure arises only for a limited range of parameters. Hence, the reasonably efficient version of price squeeze testing has a limited effect. However, as in homogenous goods Cournot competition, in the duopoly scenario the equally efficient competitor is not always satisfied. This arises here as long as:

$$8\gamma + 4\gamma^2 - 10\gamma^3 - 5\gamma^4 + 2\gamma^5 + \gamma^6 + C(32 - 44\gamma^2 + 4\gamma^3 + 17\gamma^4 - \gamma^5 - 2\gamma^6) > 0 \quad (1.112)$$

It can be shown that this inequality is never satisfied for $\gamma \in [0, 1)$ and $C \in [0, 1]$ and therefore price squeeze (and hence partial foreclosure) arises in the duopoly scenario.

It is also trivial to show that under case C since foreclosure arises price squeeze also arise. Note that under cases Bi and Bii firm I is not active downstream and therefore price squeeze allegations are hard to sustain (under the optimally set access price it can be shown that the downstream operations of firm I would not profitable).

Furthermore, predation charges cannot be sustained since the vertically integrated firm is able to cover its total costs.

1.6.2 Remedy

1.6.2.1 Price Squeeze

In this section we examine the effects of introducing an equally efficient competitor price squeeze test.

The same analysis as undertaken in section 5.4.3 is performed.

Lemma 1.10 *Under Singh and Vives model of differentiated products and downstream Bertrand competition, an equally efficient price squeeze test leads to an increase in welfare unless post remedy Entry Monopoly Pricing arises.*

In the second stage of the game the equilibrium quantities and price of the competing firms are given below:

$$q_I = \frac{2 - \gamma - \gamma^2 + C\gamma^2 - 2C + A(\gamma^2 - 2 + \gamma)}{4 - 5\gamma^2 + \gamma^4} \tag{1.113}$$

$$q_E = \frac{2 - \gamma - \gamma^2 + C\gamma + A(\gamma^2 - 2 + \gamma)}{4 - 5\gamma^2 + \gamma^4} \tag{1.114}$$

$$p_I = \frac{2 - \gamma - \gamma^2 + 2C + A\gamma + 2A}{4 - \gamma^2} \tag{1.115}$$

$$p_E = \frac{2 - \gamma - \gamma^2 + 2A + +A\gamma + C\gamma}{4 - \gamma^2} \tag{1.116}$$

In the first stage of the game firm I maximises the following Kuhn Tucker problem:

$$max_A \Pi_I = (P - C)q_I + Aq_E$$

$$\text{s.t. } q_I \geq 0, q_E \geq 0.$$

We distinguish the following cases:

Case A: Duopoly

The optimal access price is given by

$$A^{D,Dps} = \frac{-4 - 2\gamma + c\gamma^3}{2(-3+\gamma)(2+\gamma)} \tag{1.117}$$

This arises when :

$$-6C - \gamma C + 3\gamma^2 C + 4 - 2\gamma - 2\gamma^2 < 0$$

Case Bi: Only firm E produces.

The optimal access price is

$$A^{D,Eps} = 1 + \frac{C(2-\gamma^2)}{-2+\gamma+\gamma^2} \tag{1.118}$$

This arises when

$$-6C - \gamma C + 3\gamma^2 C + 4 - 2\gamma - 2\gamma^2 \leq 0$$

Case Bii: Only firm E monopoly pricing.

This case leads to the same access price, downstream price and profits as in case Bii in the pre-remedy scenario. The only difference is that firm E is able to set a downstream monopoly price for a wider range of parameters. This arises due to the equally efficient price squeeze obligation of firm I. According to this obligation the minimum price that firm I can set is $A + C$, compared to C in the pre-remedy situation. Therefore "perfect" double marginalisation can arise when:

$$q_I = 1 - \gamma - (C + A) + \gamma\frac{3}{4} \leq 0 \tag{1.119}$$

$$\Leftrightarrow C \geq -\frac{3}{4}\gamma + 1 \tag{1.120}$$

The graph below depicts these conditions. The white area represents the area in which duopoly arises under price squeeze. Above the concave line, i.e. in the shaded area, firm E is the only firm active in the downstream market. For relatively high cost, above the downward sloping straight line (which represents condition (1.120)), firm E sets a downstream monopoly pricing and therefore case Bii of the pre-remedied game arises; otherwise i.e. between the two lines, case Bi arises. Note that Entry monopoly pricing (case Bii) is more likely under an equally efficient competitor price squeeze test than in the pre-remedy game since it may arise for a lower efficiency gap (comparing conditions (1.108) and (1.120)). This occurs since firm I is required to abide with the equally efficient competitor test. Furthermore, duopoly is less likely to arise under an efficient competitor price squeeze test than in the pre-remedy case for the same underlying reason; the position of firm E improves as it competes against a "higher cost" competitor.

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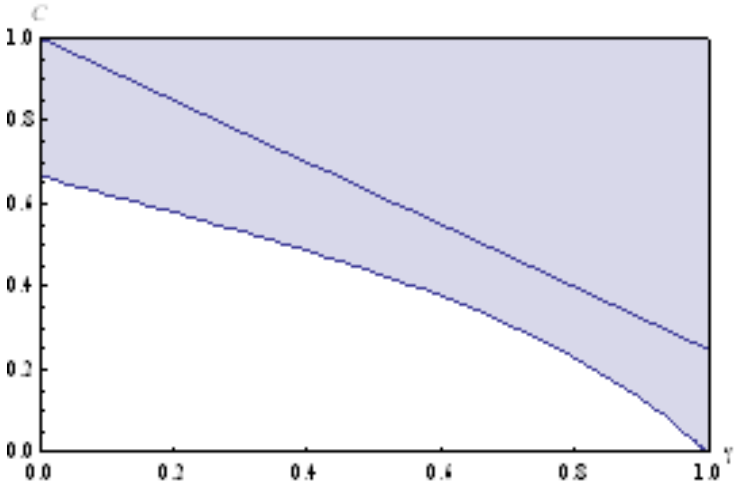
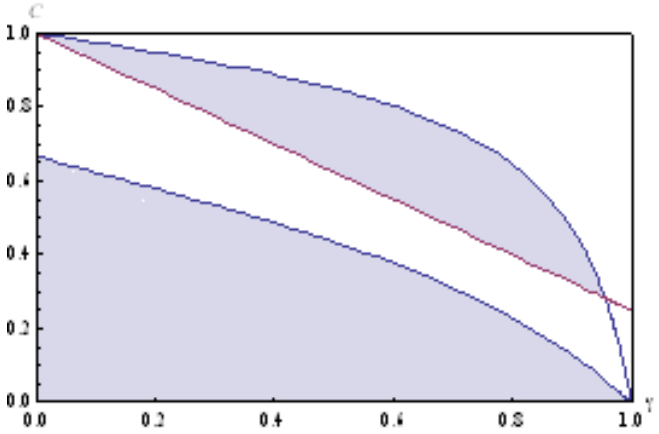


Welfare comparison Welfare unambiguously improves in the area in which, irrespective of whether or not price squeeze test is introduced, duopoly arises i.e the lower shaded area in the diagram below. The shaded area also includes the parameter range under which total foreclosure arises under no remedy. In this area welfare also unambiguously increases.

In the area between the two concave lines there is duopoly under vertical integration without price squeeze while firm E is the only firm active in the downstream market under an efficient competitor price squeeze test. Below the downwards sloping straight line firm E sets a relatively low price, constraint by the downstream operations of firm I; in this area welfare (almost unambiguously)[47] improves and the productive efficiency of firm E is passed on through lower downstream prices. However, above this line, firm E is able to set monopoly pricing downstream. This is the adverse effect of price squeeze testing which arises since under price squeeze entry with monopoly pricing is more likely than in the pre-remedy scenario. Furthermore, entry monopoly pricing is welfare detrimental since it leads to double marginalisation and therefore higher prices. Note that this effect is higher under an efficient competitor price squeeze testing. Under a reasonably efficient price squeeze testing this effect disappears since no margin is essentially assigned to firm E (see discussion in section 4.2.3)

Finally, in the area above the upper concave line, firm I is inactive under the pre-remedy scenario. As already discussed, this is not a relevant area since only in cases where firm I is active downstream competition authorities may take action.

[47]Note for completeness that for relatively high γ (γ greater than 0.94) welfare may decrease for relatively high cost differences even under this case; however, this arises for a very limited parameter range and therefore for simplicity it is not depicted in the graph.



1.7 Conclusion

In this paper we have analysed whether a vertically integrated incumbent firm has an incentive to foreclose the downstream market from efficient potential entrants. We have shown that total foreclosure can be part of the equilibrium analysis as long as there is strong downstream competition. Foreclosure arises because the vertically integrated firm cannot commit not to compete with the potential entrant once it has granted him access to its network. Furthermore, the upstream input that the incumbent possesses needs to be an essential facility that represents a significant part of the total production costs and the cost efficiency brought in the market by the entrant should be relatively small. Moreover, when the demand is very strong the incumbent will have an extra incentive to price squeeze. The degree of competition affects the strength of the commitment problem; stronger competition aggravates the commitment problem and makes total foreclosure more likely. When there is strong competition the incumbent cannot appropriate a lot of profit from the entrant through the access price and would prefer to serve the market directly. However, when there is weaker downstream competition the vertically integrated firm, may still be able to better exploit the productive efficiency of the entrant and by charging a relatively high access price it partially forecloses the entrant (raising rival's costs). Indeed, we have shown that partial foreclosure is likely to be a more pronounced effect of the pricing strategy of a vertically integrated firm.

Furthermore, contrary to the critics of price squeeze test, we have shown that predation charges are not sufficient to address the anticompetitive concern. Also, an equally efficient competitor test may improve social welfare when either total or partial foreclosure arises. At the same time we have considered the practical advantages of the price squeeze test compared to regulation, as for example it does not require to compute the upstream costs,

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and structural divestment. Therefore, in the light of the recent criticisms, it appears that the merits of price squeeze testing may have been underestimated.

The paper provides a simple background for analysis price squeeze allegations and has examined the effects of price squeeze testing under different types of competition. In order to verify the robustness of the results the model may be further extended and generalised. For example, more generic (non linear) demand functions may be taken into account. The main results of this paper should hold for more general demand functions since the nature of the commitment problem is unlikely to be significantly affected. Another interesting line of research may consider a setup where the potential entrant is only less efficient than firm I because it does not have the same scale of production as firm I. This can be modeled by introducing a fixed cost for firm E to set up its business or by allowing for an interoperability cost.

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1.9 Appendix

1.9.1 Appendix 1 Further issues on Price Squeeze testing

Another complication is that the price squeeze test should take into account possible interconnection costs. For example, if firm I has to incur additional marginal costs, Cc, to provide interconnection then these costs should be deducted from the firm's costs in order to get significant results from the price squeeze test. Therefore equation (1.2) should be adapted as follows

$$P > A - Cc + Ci$$

to guarantee that entry is encouraged only when the end costs of a vertically disintegrated competitor are not larger than the costs of providing the product in an integrated structure.[48]

Further complications arise when bypass of the upstream "essential facility" is possible or if the final downstream product is differentiated. In the bypass scenario the units of measurement become very important and it is unlikely that there would be a one to one relation between the input and the final good. Instead the firms would use the different inputs at different proportions and a meaningful price margin test has thus to incorporate this. Furthermore, it is more likely, when the downstream goods are differentiated, that rivals may make an adequate profit even though the price structure of firm I fails the equally efficient competitor test. In general, as Brunekreeft at al (2005) argue if we violate the classic Chicago style arguments (discussed in more detail in the following section), the price squeeze test "cannot achieve the goal of providing efficient signals for the downstream entry".

An additional unresolved issue, according to Bouckaert and Verboven (2003) and Geradin and O'Donoghue (2005) is whether the mixture of ex ante regulation and ex post intervention is consistent with the price squeeze test. This becomes a major concern since most cases of price squeeze allegations have been associated with the newly liberalized networks such as the telecommunication sector where regulation plays an important role. Concerning the effect of regulation on the price squeeze test Bouckaert and Verboven (2003) distinguish three cases. When both the upstream and downstream prices are regulated, the price squeeze is simply a regulatory price squeeze i.e. it arises as an artifact of regulatory choice. When instead only the upstream price is regulated then the incumbent firm can affect only the downstream price, which may only raise predatory concerns. Finally, when both markets are unregulated, the incumbent firm may price squeeze, predate or use excessive pricing.

[48] To see this imagine the case where firm E is more efficient than firm I, however, it produces at a higher cost when the interconnection costs are also accounted for (i.e. $Ce + Cc > Ci$). If an equally efficient competitor test is considered then firm E would be able to undercut the vertically integrated firm. However, the total costs of the entrant would be higher compared to the monopolist, thereby inviting inefficient entry.

Geradin and O'Donoghue (2005) argue that the greater the pricing flexibility (and therefore the less the regulatory intervention) the more likely is that price squeeze could occur.

1.9.2 Appendix 2 Social welfare under Perfect Competition

$$W^E = \frac{(Z - V - 2Ce + Ci)(Z - V - Ci)}{2} < W^C = \frac{(Z - V - Ce)^2}{2}$$

Opening the parentheses and simplifying:

$$\iff 2CiCe - Ci^2 < Ce^2$$

$$\iff (Ci - Ce)^2 > 0$$

which holds

1.9.3 Appendix 3 Social Welfare under reasonable efficient competitor test

$$W^{m_{(V+Ce)}} = W^{\delta=Ce} < W^E$$

$$3(Z - V - Ce)(Z - V - Ce)/8 < (Z - V - 2Ce + Ci)(Z - V - Ci)/2)$$

$$\iff \frac{3}{4}(Z - V - Ce)(Z - V - Ce) < (Z - V - Ci)(Z - V - Ce) + (Z - V - Ci)(Ci - Ce)$$

$$\iff (Z - V - Ce)[\frac{3}{4}(Z - V - Ce) - Z + V + Ci] < (Z - V - Ci)(Ci - Ce)$$

$$\iff (Z - V - Ce)\frac{1}{4}[(V + Ci - Z) + 3(Ci - Ce)] < (Z - V - Ci)(Ci - Ce)$$

which holds under equation 1.29 given that

$$(V + Ci - Z) + 3(Ci - Ce) < 0$$

$$\iff Z - V - Ci > 3(Ci - Ce)$$

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1.9.4 Appendix 4 Structural remedy

In this Appendix we solve the structural remedy game for all value parameters and we examine the effects of introducing i) price discrimination or ii) two part tariff.

Under Bertrand competition firm E always operates in the downstream market. When there are small cost asymmetries the game is as described in 4.2.1. However this outcome arises as long as $A + Ci < \frac{Z+A+Ce}{2}$. Substituting for the optimal access price (1.36) we observe that this scenario may arise only when $Z - V - Ci > 2(Ci - Ce)$ i.e. when the cost difference is relatively small. Under large cost asymmetries, both firm I (upstream) and E (downstream) operate as a monopolist leading to the outcome of case (Aii) of the game in 4.1. By comparing the profits of firm I in both cases the latter case is optimal when $Z - V < \frac{1}{\sqrt{2}-1}(\sqrt{2}Ci - Ce)$ while the small cost asymmetries outcome arises when $Z - V > \frac{1}{\sqrt{2}-1}(\sqrt{2}Ci - Ce)$.

In 4.2.1 we have demostrated that structural remedy is welfare enhancing when the cost difference between the two firms is small (when $5Ci - 4Ce < Z - V$).

When $5Ci - 4Ce > Z - V > \frac{1}{\sqrt{2}-1}(\sqrt{2}Ci - Ce)$ firm I's profits and social welfare fall following divesment. Under vertical integration Entry Bertrand pricing takes place while under divestment, the outcome described in 4.2.1 arises. Welfare falls since the downstream price under structural separation is higher. The pricing condition in the vertical integration scenario (1.7) does not depend on A and therefore determines the final price while under structural divestment there is a further maximisation problem at stage 1 leading to monopoly pricing (1.37). As a result under vertical integration double the output is produced.

When $\frac{1}{\sqrt{2}-1}(\sqrt{2}Ci - Ce) > Z - V > 1/3(Ci - Ce)$ the outcome under divestment is welfare detrimental since it leads to "perfect" double marginalisation and therefore to higher price compared to the Entry Bertrand pricing outocme under vertical integration. Firm I is worse off since it cannot extract the whole productive efficiency of firm E (firm I' has costs of $A + Ci$ versus total costs of $V + Ci$ under vertical integration). One notes that the "perfect" double marginalisation scenario is more likely to arise under strucrural divestment. This happens since firm E can only set monopoly price when this is lower than $A + Ci$ (the costs of the independent I') under structural divestment while lower than $V + Ci$ under vertical integration.

Note that firm I is weakly worse off in the divestment scenario; this arise since by vertically integrating it internalises part of the downstream externality thereby enjoying higher profits (partially restoring monopoly power).

As discussed in 4.2.1, double marginalisation arises because of linear pricing. Firm I

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can do better under the divestiture scenario and receive the monopoly profit of a firm with underlying costs $V + Ce$, through i) price discrimination or ii) two part tariff (if observable contracts are assumed).

If we assume that firm I can credibly price discriminate in the access price then firm I could set Ai and Ae such that

$$P = Ci + Ai = Ce + Ae \tag{1.121}$$

with $Ae > Ai$.

We assume that, as a tie break rule, firm E serves the market. In the first stage of the game firm I will maximise its profits with respect to Ae which yields

$$P = \frac{Z + V + Ce}{2} \tag{1.122}$$

The profits of firm I are given by:

$$\Pi_I = \frac{(Z - V - Ce)^2}{4} \tag{1.123}$$

and are higher than under foreclosure (equation (1.28)). We note that essentially firm I is able to set the access prices, Ae, above the marginal cost of the upstream production offsetting the externality problem created by the downstream competition. Here firm I solves the commitment problem (as long as such a price discrimination is credible) and is able to appropriate monopoly profits of a firm of the efficiency of firm E.

Alternatively, a two part tariff of the form $R + Aq$ (see also section 4.2.4) can be imposed. In the second stage of the game, since $A + Ce \leq A + Ci$, firm E serves the market at price $P = A + Ci$. By imposing an access price

$$A = \frac{Z + V + Ce - 2Ci}{2} \tag{1.124}$$

firm I "dictates" the monopoly price that maximises the profits of a vertical integrated monopolist with downstream costs Ce. Note that this access price is lower than (1.36). Firms E and I make respectively profits

$$\Pi_E = \frac{(Ci - Ce)(Z - V - Ce)}{2} - R \tag{1.125}$$

$$\Pi_I = \frac{(Z - V + Ce - 2Ci)(Z - V - Ce)}{4} + R \tag{1.126}$$

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If firm I has all the bargaining power then firm I can appropriate all the profits and achieves

$$\Pi_I = \frac{(Z - V - Ce)^2}{4} \tag{1.127}$$

Therefore, under divestment if price discrimination and/or two part tariff are introduced, the dominant firm can increase the profits it can receive, at the expense of the entrant but at the benefit of social welfare. However this assumes that contracts are observable and cannot be renegotiated. Note that the nature of the commitment problem is somewhat different than under vertical integration. In the latter scenario. the vertically integrated firm cannot commit not to compete downstream since its own operations are active in the second stage of the game; under divestment the upstream monopolist is not active downstream (see section 4.2.4).

1.9.5 Appendix 5 Price Squeeze testing

We analyse the game in 4.2.3 for $\delta = Ci$. In the second stage of the game we distinguish 2 scenarios over which firm I can choose by setting A appropriately;

A) small cost asymmetries when $P = A + Ci$ which requires $A + Ci < \frac{Z+A+Ce}{2}$

B) large cost asymmetries when $P = \frac{Z+A+Ce}{2}$which requires that $A + Ci > \frac{Z+A+Ce}{2}$

Under A) small cost asymmetries in the first stage of the game

$$max_A(A - V)(Z - A - Ci)$$

$$\text{s.t. } A + Ci < \frac{Z + A + Ce}{2}$$

Case Ai: When the constraint does not bind $A = \frac{Z+V-Ce}{2}$, $P = \frac{Z+V+Ci}{2}$, $\Pi_I^{Ai} = \frac{(Z-V-Ci)^2}{2}$

This is the case mentioned in 4.2.3.

This is optimal when

$$Z - V - Ci > 2(Ci - Ce)$$

Case Aii: When the constraint binds $A = Z + Ce - 2Ci$, $P = Z + Ce - Ci$, $\Pi_I^{Aii} = (Ci - Ce)(Z - V - Ci - Ci + Ce)$

Under **B) large cost asymmetries**, in the first stage

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$$max(A-V)(Z-\frac{Z+A+Ce}{2}-Ci)$$

$$\text{s.t. } A+Ci>\frac{Z+A+Ce}{2}$$

Case Bi: When the constraint does not bind $A=\frac{Z+V-Ce}{2}$, $P=\frac{Z+V+Ce}{2}$, $\Pi_I^{Bi}=\frac{(Z-V-Ce)^2}{8}$

This is optimal when the cost difference is relatively large:

$$Z-V-Ci<3(Ci-Ce)$$

Case Bii: When the constraint binds $A=Z+Ce-2Ci$ is identical to Case Aii.

Comparing the profits of firm I:

Case Ai arises when $Z-V>\frac{1}{\sqrt{2}-1}(\sqrt{2}Ci-Ce)$ while Bi arises when $Z-V<\frac{1}{\sqrt{2}-1}(\sqrt{2}Ci-Ce)$.

This is the same outcome as under structural divestment and therefore the same welfare considerations apply.

1.9.6 Appendix 6 Cournot Duopoly profits

$$\Pi_I^{C,D}=(A-V)qe+(P-V-Ci)qi$$

where

$$qe=\frac{2(Ci-Ce)}{5}$$

$$qi=\frac{Z-V-Ci}{2}-\frac{Ci-Ce}{5}$$

$$\Pi_I^{C,D}=(\frac{5Z+5V-Ci-4Ce}{10}-V)(\frac{2(Ci-Ce)}{5})$$

$$+(\frac{5Z+5V+5Ci-2(Ci-Ce)-10V-10Ci}{10})(\frac{Z-V-Ci}{2}-\frac{Ci-Ce}{5}$$

$$\Longleftrightarrow \Pi_I^{C,D}=\frac{1}{100}[4(5Z-5V-Ci-4Ce)(Ci-Ce)+(5Z-5V-5Ci-2(Ci-Ce))^2]$$

which simplifies to

$$\Pi_I^{C,D} = \frac{(Ci - Ce)^2}{5} + \frac{(Z - V - Ci)^2}{4}$$

$$\Pi_E^{C,D} = (P - A - Ce)qe$$

which simplifies to

$$\Pi_E^{C,D} = \frac{4(Ci - Ce)^2}{25}$$

$$S^{C,D} = \frac{1}{8}(Z - V - Ci)^2 + \frac{1}{10}(Z - V - Ci)(Ci - Ce) + \frac{1}{50}(Ci - Ce)^2$$

$$W^{C,D} = \frac{3}{8}(Z - V - Ci)^2 + \frac{19}{50}(Ci - Ce)^2 + \frac{1}{10}(Ci - Ce)(Z - V - Ci)$$

1.9.7 Appendix 7 Welfare considerations

$$P^{C,D} > P^{C,E}$$

$$(Z + V + Ci) - \frac{1}{5}(Ci - Ce) > V + Ci$$
$$\iff 5Z + 5V + 5Ci - 2Ci + 2Ce > 10V + 10Ci$$

$$\iff (Z - V - C) > \frac{2}{5}(Ci - Ce)$$

Similarly welfare under duopoly exceeds welfare under scenario B iff:

$$\iff \frac{19}{50}(Ci-Ce)^2+\frac{3}{8}(Z-V-Ci)^2+\frac{1}{10}(Z-V-Ci)(Ci-Ce) > \frac{1}{2}(Z-V-Ci)^2+(Z-V-Ci)(Ci-Ce)$$

$$\iff \frac{19}{25}(Ci - Ce)^2 > \frac{1}{4}(Z - V - Ci)^2 + \frac{9}{5}(Z - V - Ci)(Ci - Ce)$$

$$\iff \frac{100}{25}(Ci - Ce)^2 > (\frac{1}{2}(Z - V - Ci) + \frac{9}{5}(Ci - Ce))^2$$

$$\iff (Z - V - C) > \frac{2}{5}(Ci - Ce)$$

CHAPTER 2

LENIENCY POLICY'S DETERRENT EFFECTS ON FAILING CARTELS

2.1 Introduction

The fight against cartels has long been at the forefront of competition authorities' concern in both sides of the Atlantic.[1] Commissioner Neelie Kroes[2] stated that cartel enforcement "is at the very top of the priorities of the Commission". Besides, the huge increase in the number of detected cartel cases and in the average size of fines imposed on firms in connection to cartel activity in the EC (see Appendix 2.7.1) demonstrates the EC commitment against cartels.

Leniency policy is a program that grants a reduction in the fine imposed to the colluding firm(s) that reports the cartel activity to the antitrust authorities. This can destabilise the cartel activity by putting the firms against each other since only the first one to report the anticompetitive practice will benefit from full immunity from the fine.[3] An effective leniency program will lead cartel members to confess their conduct to the authorities (desistance) but also will discourage firms from joining a cartel agreement in the first place (deterrence). The introduction of leniency programs is viewed as the biggest success for cartel detection and deterrence leading to a dramatic increase in the number of cases brought to the attention of the antitrust authorities. Hammond (2000) views the Amnesty program in the US as "unquestionably the most important investigative tool available for detecting and cracking cartel activity". The greatest advantage of a leniency program is that it brings crucial evidence to the antitrust authorities. In cartel cases the establishment of guilt can become very difficult without the discovery of an explicit agreement and therefore leniency can greatly facilitate this information gathering. Much attention has been attracted in leniency after the revision of the leniency program in the US in 1993. Since then, leniency programs have been introduced in more than 30 countries and in the European Commission. The figure in Appendix 2.7.2 demonstrates the crucial role of the leniency program in practice. It shows

[1] European Competition Law Annual (2006), introduction p.i

[2] In the opening speech at the 11th Competition Law and Policy Workshop, EUI, 2006.

[3] In many systems, including the EC, there is some fine reduction for the second informant as long as it provides the authorities evidence with "significant value added", but only the first reporting firm could obtain immunity.

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that the great majority of cases prosecuted by the EC since 2000 involve firms that received immunity from fines, due to the leniency program.

Nevertheless, despite this apparent success in practice, there are some more skeptical views arguing that leniency applications might not be as effective. First, the main problem with cartels is that we cannot know how many of them exist in our economy. Therefore, it is empirically very hard (if not impossible)[4] to estimate whether the introduction of the leniency program has increased deterrence. The higher number of prosecuted cases could simply be the result of an increase in cartel activity. Furthermore, leniency inherently lowers the expected fine for the firms and therefore reduces the expected cost of entering into cartels. Therefore, an important trade off arises (see Motta and Polo (2003), Chen and Rey (2007)): while leniency programs induce firms to report their information and evidence to the antitrust authorities (the procompetitive effect), they also reduce the expected penalty that firms will face when they enter such an agreement (the anticompetitive effect). Moreover, there are concerns that the EC leniency program is not effective in itself; instead it benefits from the effectiveness of the US leniency program, which induces firms to also apply for leniency in the EC (see Stephan (2005)).[5]

Finally, and most relevant for our paper, some practitioners and academics have argued that leniency programs (only) attract failing cartels and would therefore not improve ex ante deterrence. More specifically, Stephan (2005) finds that many cartels discovered through leniency applications "had failed or ceased to operate because of market conditions (...), before being revealed to the Commission by a cartel member". For example, the Carbonless Paper cartel (2001) faded because the market for self copying paper was in decline in the face of new technology. In the case with the highest fine at the time, the Vitamins cartel (2001), the colluding agreement had ceased in most market segments, due to the emergence of new Chinese products. The Sodium Gluconate cartel (2002) suffered from falling profits due to escalating production costs throughout the 1990s. Therefore, Stephan (2005) considers that leniency applications are a consequence of "leaving the sinking ship" with firms looking to their interest. Furthermore, concerning deterrence he suggests that "the leniency notice may have benefited collusion by taming the endgame for one of the players". In a similar spirit, Guersent (2006) suggests that "firms usually do not rush to report young and well functioning cartels; they only come in and apply for leniency policy when things become more problematic". Also Grout (2006), commenting on the results obtained by Langus and

[4] See Harrington (2006) and Miller (2007) for a suggested methodology.

[5] The greatest difference between the two legal systems is that in the US individuals involved in the collusive activity can be criminally charged and fined with imprisonment. This provides a greater incentive to apply for leniency since there is more than company profits at stake.

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Motta (2007) on the effect of an antitrust investigation to the stock market valuation of a firm, argues that financial markets must predict that the "detected cartels must not have much life left in them".[6]

This paper aims to investigate the argument that leniency programs only attract failing cartels. This would enable us to examine whether the introduction of leniency programs enhances deterrence and would guide us to provide some policy conclusions. In a context of perfect information, and with given probability of detection, we show that firms would internalise the presence of leniency programs into their ex ante decision to collude. Therefore, we would observe no leniency applications at equilibrium since firms would be able to predict that the cartel they enter is unstable.[7] In order to model a framework where firms only apply for leniency when the cartel is fading we introduce imperfect information. In a setting where there are possible profitability shocks in the economy, firms will take the decision on whether to enter cartel agreements by taking an expectation over the possible states of nature. However, at some point the uncertainty over the state of the economy would dissolve and firms would have to decide whether they still want to be part of this collusive agreement. In the presence of a leniency program, we shall show that firms might prefer to report the illegal activity when the bad state of nature materialises. The important question that arises is whether these leniency applications are a worthy target for the antitrust authorities given that these cartels will collapse in any case.

2.2 Literature review

Our paper adds to the literature on the effectiveness of the leniency schemes initiated by Motta and Polo (2003). Much of the literature focuses on the issue of deterrence and therefore in most models there is no reporting arising at equilibrium. We, instead, first analyse what triggers a leniency application and then focus on the implications on deterrence.

A first reason for applying for leniency that has been identified in the literature is a change in the probability of detection. Motta and Polo (2003) show that firms apply for leniency if an investigation has opened in the industry where the cartel activity takes place. This induces an increase in the probability of detection and therefore following the opening of an investigation firms will have a greater incentive to report. Harrington (2005) allows the probability of detection to vary over time and shows that offering leniency can lead to desis-

[6] Taking the conservative estimates of Langus and Motta (2007) this effect can be as low as 2%. Grout (2006) argues that the future loss of the benefit of cartel induced supra competitive prices seems to be of relatively little importance. This is based on the perception that the share prices are often very responsive even to minor events.

[7] As a result, only the introduction of a leniency program might lead to applications. However, in practice one can observe leniency applications that go beyond the period of the introduction of the leniency programs.

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tance when discovery becomes more likely. A second reason to apply for leniency arises when the fines depend on the duration of the cartel activity. In such a setting firms might prefer to collude and then reveal in order to avoid paying the accumulated fine (see Motchenkova (2004)). Another possibility is that a change in the management might trigger the leniency application. Or, the management was not aware of the illegal activity and upon discovery it runs to the antitrust authorities. Indeed in the Monochloroacetic Acid cartel (2005) when Hoechst chemicals discovered that the newly acquired Clariant business management had engaged in collusive activities it filed for leniency. Last, Siragusa (2006) suggests that there might be strategic motives behind a leniency application i.e. firms exploit leniency programs for competitive or exclusionary reasons. However, in the theoretical models that incorporate strategic behavior (Ellis and Wilson (2003), Leliefeld and Motchenkova (2007)) no leniency applications arise at equilibrium since firms internalise the strategic considerations in their ex ante decision.[8]

Concerning the optimal structure of leniency programs, it is well established in the literature (see Harrington (2005), Chen and Rey (2007)) that providing leniency only to the first informer would make the cartel less sustainable and would create a race to the courthouse effect. Introducing the risk dominance concept, Spagnolo (2004) argues that such a program risk dominates a scheme with multiple fine reductions, which instead reduce the deterring effect of the leniency programs. He also finds, contrary to our model, that courageous leniency programs in which the reporting party is granted rewards are the first best solution. However, moderate leniency systems as currently employed by the EC and US can be helpful. On the other hand, leniency programs can be exploited by firms and this should determine a maximal level of leniency. Building on this framework, Chen and Rey (2007) propose a normative framework to study the effects of the leniency policy by introducing heterogeneity in the stakes of collusion across industries. This allows them to "characterise the objective of the antitrust authority, that is, deterring as many as possible cartels by an upper bound of collusive benefits".

The model we present also relies on the literature of the impact of the evolution of demand on cartel formation. The starting point of this literature is the paper by Rotemberg and Saloner (1986). They assume that the level of market demand is independently and identically distributed so that the expected level of future demand is independent of the present state of demand. This implies that the expected cost (or benefit) of deviating from

[8] For example, Ellis and Wilson (2003) assume that the reporting firm enjoys a market advantage from self reporting since the convicted firms would suffer from a wedge between marginal cost and marginal revenues. They find that the leniency policy might strengthen cartels by increasing the punishment that may be inflicted on a deviator.

(sticking to) the illegal agreement is always the same regardless of the current state of demand. However, a high demand today makes a deviation more attractive since the higher prices make a price cut more attractive. Therefore, when demand is in the good state of the economy, collusion is harder to sustain. Introducing, however, positive correlation between the state of the economy today and tomorrow changes the results. In a setting where the demand boom is expected to be persistent, the carrot from colluding increases substantially, rendering collusion more likely. Conversely, if the demand is expected to fall persistently collusion becomes less of an attractive option since the firms would not have much to gain from sticking into an illegal agreement. In this spirit are the findings by Haltiwanger and Harrington (1991) and Bagwell and Staiger (1997) who study the incentives to enter a cartel agreement assuming a model of business cycle where demand movements are cyclical over time.

2.3 The model

2.3.1 The market setup

We consider a simple game where there are two firms that are symmetric and they compete in prices in the market of a homogeneous good in an infinitely repeated game. The discount rate is identical for both firms and is denoted by $\delta \in (0,1)$. We assume that the profit per firm from colluding in the first period is π and the profits from deviating from the colluding agreement when the other firm colludes is 2π, in which case the other firm earns 0. Further, the profits in the market follow a downwards trend. More specifically, they follow the process: $\theta^t \pi(p)$ with $\theta \in (0,1]$ i.e. they weakly fall in each period by a fraction θ. The idea is that the industry faces a negative shock on profitability which could be due to, for example, a demand reduction or a cost increase. We also assume that firms attempt to sustain collusion by employing standard trigger strategies, threatening with reversion to the one period Nash outcome of no collusion when one firm deviates.

2.3.2 The Antitrust Authority and the Leniency Program

The antitrust authority in our model has the legal power to investigate all the sectors of the economy but (has limited resources and) can detect an infringement of competition law relying on audits with a probability $\rho \in [0,1)$ in each period. When an antitrust authority finds a cartel it sets to the parties involved in the illegal activity a fine equal to $F_t = \lambda \pi_t$, with λ being the coefficient of the proportional fine. This assumption reflects the current revision

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in the way the European Commission calculates the fines it sets.[9] Note that this assumption is crucial to render the problem stationary; if the fine was fixed then with strictly falling profits the decision to collude or not (and to report or not) would depend on the period where we are. Furthermore, we assume that the evidence of collusion lasts for only one year which implies that firms cannot be fined for past activity. The antitrust authority can impose a maximal fine F that is not enough to deter collusion given the probability of detection ρ i.e. we assume that $\pi - \rho F > 0$. Moreover, the investigations that we consider are secret investigations in the sense that firms do not have the opportunity to apply for leniency after the antitrust authority has opened an investigation.

The antitrust authorities also have in place a leniency program. Firms can report to the antitrust authorities the existence of a collusive agreement. When one firm reports then it benefits from a reduction $q \geq 0$ on the fine normally levied on it. We assume that a fine reduction is only available to the first informant and therefore when both firms decide to report simultaneously, they each have a chance of one half to be the first to report. Following reporting, trust is broken and no further collusion could arise. From the next period onwards the firms revert to the static Nash equilibrium. We make this assumption in order to rule out the rather unrealistic possibility that firms collude and report in every period.[10] Aubert et al (2006), among others, argue that it is very unlikely that antitrust authorities would not spot this kind of collusive behavior, and therefore they also exclude it from consideration.

Finally, the antitrust policy parameters are exogenously fixed in the beginning of the game and are common knowledge to the firms.

2.3.3 The timing of the game

In the first period of the game the timing is as follows:

Stage 1. The two firms simultaneously decide whether they want to enter into a collusive agreement or not. Only if both firms decide to collude then the cartel is formed, otherwise, competition takes place. In this latter case each firm gets zero profits and the game ends for this period.

Stage 2. If a cartel is formed in stage 1, each firm decides whether it wants to stick to the colluding agreement or to deviate in the product market and earn a payoff of 2π. If at least one firm deviates, collusion can not arise anymore; otherwise, each firm gets the collusive profits. Then market realisation occurs.

[9] More specifically, EC has moved towards a setting that the level of fines reflects the turnover of the companies in question (% of the firm's relevant turnover).

[10] Or to report once, collude and never report afterwards in a setting where no leniency for repeated offenders is offered, see Chen and Rey (2007).

Stage 3. Nature draws the state of the economy. With probability α the profits will be stable forever ($\theta = 1$) and with probability $1 - \alpha$ the market will shrink by $\theta < 1$ in each period.

Stage 4. Firms decide whether they want to report the infringement to the antitrust authorities. The antitrust authority detects cartels with probability ρ (a collusive agreement that has not survived stage 2 cannot be detected). When the cartel is detected, or reported, firms are charged with the corresponding fine. Firms still earn the collusive payoffs for this period.[11] However, from the next period they return to the one stage Nash equilibrium.[12]

From period 2 onwards the game is repeated with no uncertainty on the profit realisation.

Note that in our model, we assume that firms obtain the colluding outcome even if they decide to report in the same period. More specifically, following Chen and Rey (2007), the market realisation takes place before the antitrust authorities intervene in the market. This assumption to some extent reflects the requirement of the European Commission for leniency applicants not to terminate their role in the illegal activity immediately (so as to be able to make dawn raids in the conspirators' premises that would yield some evidence).

2.4 Perfect Information: a benchmark scenario

We first consider the scenario of perfect information i.e. when the firms know the state of the economy. This scenario will be the building block for the whole game since in the subgames that start from period 2 onwards there is perfect information.

One notices that under perfect information if a firm finds it optimal to report in the second period of the game it would also be optimal to report in the first period. This happens because the environment does not change and therefore the same considerations will take place in each period. Therefore, similar to Motta and Polo (2003), we shall focus on two relevant collusive strategies: one is to collude and report in the first period (CR) and the second is to collude and never reveal (CNR).

Note that the present discounted value of colluding and not reporting, V^{cnr}, is:

$$V^{cnr} = \pi - \rho F + (1-\rho)\theta\delta(\pi - \rho F) + ... = (\pi - \rho F)(1 + (1-\rho)\delta\theta + ...) = \frac{(\pi - \rho F)}{1 - (1-\rho)\delta\theta}$$

[11] Following Chen and Rey (2007), the market realisation takes place before the antitrust authorities intervene in the market. This assumption to some extent reflects the requirement of the European Commission for leniency applicants not to terminate their role in the illegal activity immediately (so as to be able to make dawn raids in the conspirators' premises that would yield some evidence).

[12] This can be modeled explicitly by assuming for example perfect monitoring in the markets where an infringement has been detected, or immense fines for repeat offenders. Note that the EC new Guidelines on fines (2006) have a tougher stance against repeat offenders

whereas the present discount value of colluding and then reporting, V^{cr}, is:

$$V^{cr} = \pi - (1 - \frac{q}{2})F$$

We solve the game using the Subgame Perfect Nash Equilibrium solution concept. Proceeding with backward induction we need to consider two subgames.

2.4.1 The revelation subgame

First, we consider the reporting decision. When firms have entered into a collusive agreement one can depict the game in the following reduced[13] normal form game

	report	no report
report	$\pi - (1 - \frac{q}{2})F, \pi - (1 - \frac{q}{2})F$	$\pi - (1 - q)F, \pi - F$
no report	$\pi - F, \pi - (1 - q)F$	$\frac{(\pi - \rho F)}{1-(1-\rho)\delta\theta}, \frac{(\pi - \rho F)}{1-(1-\rho)\delta\theta}$

One can easily verify that the pair (report, report), in which the firms decide to reveal their illegal activity to the antitrust authorities is always a Nash Equilibrium. When leniency is relatively small, with $\pi \leq (1-q)F$, the pair (no report, no report) also always constitutes a Nash equilibrium. When $\pi > (1-q)F$ the pair (no report, no report) is also a Nash Equilibrium if:

$$\frac{(\pi - \rho F)}{1 - (1 - \rho)\delta\theta} \geq \pi - (1 - q)F$$

$$\iff \delta \geq \frac{F(\rho - (1 - q))}{\theta(1 - \rho)(\pi - (1 - q)F)} \equiv \delta_1 \tag{2.1}$$

One notes that the higher the leniency offered the more fragile the cartel agreement is made since firms would have stronger incentives to report.[14]

When the pair (no report, no report) constitutes an equilibrium then it is also Pareto dominant, i.e. both firms will prefer to remain silent than to run into the antitrust authorities' leniency program. We shall assume throughout the paper, as in Motta and Polo (2003), that when there is a Pareto Dominating equilibrium firms would be able to coordinate on it.

[13] We assume that the continuation game of (no report, no report) is to collude and never report forever and therefore we introduce the present discounted value of collude and never report in the (no report, no report) outcome.

[14] More specifically, the first derivative of δ_1 with respect to q can be shown to be always positive and therefore for a higher level of leniency the threshold of the discount factor for sustaining collusion increases.

2.4.2 The Cartel Formation subgame

Now moving backwards we have to examine the Cartel Formation subgame, i.e. whether the firms have an incentive to deviate from the collusive agreement in the product market.

When $\delta \geq \delta_1$.

In this case the firms prefer not to report.[15] The present discounted value of colluding (and not reporting) is V^{cnr}, and the relevant product market deviation is that firms undercut each other and obtain the whole market: $V^d = 2\pi$.

Therefore, the incentive compatibility constraint for the firms to join the collusive agreement is that:

$$V^{cnr} \geq V^d = 2\pi$$

$$\Longrightarrow \delta \geq \frac{(\pi + \rho F)}{2\pi\theta(1-\rho)} \equiv \delta_2 \tag{2.2}$$

Note that the critical discount factor value, δ_2, is inversely related to the size of the shock, θ. Collusion becomes more likely as $\theta \to 1$. On the other hand, collusion is less likely to be sustainable for small values of θ i.e. when the fall in the profits in every period is more severe. When the future of the economy is grim, there is a greater incentive to deviate on the relatively large collusion profits enjoyed in the current period.

Therefore, a necessary condition for firms colluding and never reporting is that $\delta \geq \max(\delta_1, \delta_2)$ since both conditions (2.1) and (2.2) need to be satisfied.

When $\delta < \delta_1$.

In this case firms prefer to report in the revelation game. In the Cartel Formation subgame firms prefer to collude when the present discount value of colluding and then reporting, V^{cr}, is greater than the product market deviation, V^d:

$$V^{cr} = \pi - (1 - \frac{q}{2})F \geq 2\pi = V^d$$

$$\Longrightarrow q \geq \frac{2(\pi + F)}{F} = 2 + \frac{2\pi}{F} \equiv q_1$$

For firms to have an incentive to enter a collusive agreement and then report, it has to be that the leniency that the antitrust authoritiy offers is much greater than 1 i.e. when it offers rewards. This is the case of "exploitative" leniency policy: the leniency policy is so attractive that it induces firms to collude in order to take advantage of its rewards. Note

[15] As long as $\pi > (1-q)F$. Otherwise for any discount rate the firms would prefer not to report in the revelation subgame.

that this condition does not depend on the discount rate since once reporting takes place firms cannot collude any longer and all the future payoffs are zero.

Lemma 2.1 *The introduction of a leniency policy under perfect information when no rewards are allowed is completely ineffective i.e. it does not affect the rate of cartel formation nor the cartel desistance. Firms will prefer to collude when* $\delta \geq \delta_2$.

Proof: To assess the effectiveness of the leniency program we have to compare the case where $q = 0$ with the case where $q \in (0, 1]$. When no leniency program is adopted, i.e. $q = 0$, firms have no benefit from reporting. On the other hand, reporting brings costs to the firms since they would have to pay the fine with certainty and not only the expected fine. As we have shown above even when $q \in (0, 1]$, as long as no rewards are offered, reporting cannot arise as an equilibrium outcome. Therefore, leniency does not enhance desistance. Further, when no rewards are allowed $\delta_1 < \delta_2$. Suppose the contrary:

$$\delta_2 = \frac{(\pi + \rho F)}{2\theta\pi(1-\rho)} < \frac{F(\rho - (1-q))}{\theta(1-\rho)(\pi - (1-q)F)} = \delta_1 \Longrightarrow$$

$$q > 1 + \frac{\pi(\pi + \rho F)}{F(\pi - \rho F)} - \frac{2\pi F\rho}{F(\pi - \rho F)}$$

This is a contradiction since it requires that

$$\frac{\pi(\pi + \rho F)}{F(\pi - \rho F)} < \frac{2\pi F\rho}{F(\pi - \rho F)} \Longrightarrow 0 > \pi - \rho F$$

i.e. that each period's expected profits when colluding are negative, which by assumption cannot occur.

This implies that introducing leniency is irrelevant in the ex ante decision of the firms to enter a collusive agreement or not. We still require that $\delta \geq \delta_2$. Therefore, leniency also has no effect on deterring collusion.

This result should come at no surprise since firms have exactly the same information before reporting as in the cartel formation subgame. Firms would have no incentive to report unless leniency offers rewards, and therefore their ex ante decision to enter a cartel agreement would not be affected. Firms simply collude when the product market deviation is not profitable.

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2.5 Imperfect Information Scenario

The interesting result of the above analysis is that under perfect information the firms will collude and report only when there is a very large reward. Therefore, in the equilibrium with no rewards there would be no applications for leniency. This seems to contradict what actually happens in practice. This is precisely the puzzle that we are trying to understand and analyse why do firms apply for leniency. We present a model where the collapse of collusion would provide the incentive to the firms to report their illegal activity. We introduce "imperfect" information[16] by allowing for the sequence of profits in the market to be uncertain at time $t = 1$. We assume that with probability $1-\alpha$ a negative shock will hit this sector of the economy in every period (bad state of economy), i.e. $\theta < 1$. With probability α profits will be stable forever (good state) i.e. $\theta = 1$. Note that the results hold for any two values of θ as long as they are not identical.[17] Remember that from period 2 onwards there is no uncertainty on the profit realisation. In what follows we shall assume that there are no rewards to leniency applicants, as is currently the case in the vast majority of antitrust policies in the world.

To solve this game we need to consider first the subgames that start in the second period. Since uncertainty is thereafter dissolved, the conditions we obtained under perfect information hold. We have to consider three cases concerning the optimal strategy of the firms starting from period 2. This happens because the incentive compatibility constraint in the product market is more easily satisfied when we are in the good state of the economy. Recall from equation (2.2) that δ_2 is an decreasing function of θ and therefore when $\theta = 1$ the condition is satisfied for a greater range of values of the discount factor. We obtain two rather trivial cases and one more interesting:

If $\delta < \delta_{2,\theta=1}$.

In this scenario firms will never collude in the perfect information scenario regardless of the state of the economy. Therefore, since from period 2 onwards firms will prefer not to collude, the only Nash Equilibrium is to also not collude in the first period of the game.

If $\delta \geq \delta_{2,\theta<1}$.

In this case we already know that firms will always collude from period 2 onwards. It comes as no surprise that also in the first period the firms prefer to collude.[18] Note that for

[16] Technically, we introduce uncertainty (and not imperfect information) in the first period of the game. If, however, Nature chooses in the first stage of period 1 and the firms observe this only in stage 4, then our game is an imperfect information game. Otherwise, we have perfect information with 3 players (the two firms and Nature).

[17] The main results also hold for positive values of θ.

[18] Now the relevant deviation is whether:
$\alpha(\frac{(\pi-\rho F)}{1-(1-\rho)\delta}) + (1-\alpha)(\frac{(\pi-\rho F)}{1-\theta(1-\rho)\delta}) \geq 2\pi \Longrightarrow$

$a = 0$ or $a = 1$ we obtain the corresponding perfect information cases.

If $\delta \in [\delta_{2,\theta=1}, \delta_{2,\theta<1})$**.**

This is the interesting case. Here collusion would only be optimal from period 2 onwards as long as the high state of the economy has occurred. On the other hand, when the bad state occurs, firms prefer to compete since they cannot credibly commit not to deviate in the product market. On what follows we assume that the discount factor falls in this range. We also make the assumption that firms cannot have strategies of the type "wait and see". Firms have to decide today whether they want to take part in the illegal activity; they would not have this possibility tomorrow unless they decide to collude today. We now move backwards into the first period of the game.

2.5.1 The revelation subgame

We first analyse the two Revelation Subgames in the first period:

When $\theta = 1$ **(good state occurs) :**

the normal form game would be written exactly as in the full information game with $\theta = 1$ since the continuation value of all actions is unaltered. Therefore the pair (no report, no report) is the Pareto dominating equilibrium (since also $\delta \geq \delta_{2,\theta=1}$).

When $\theta < 1$ **(bad state occurs)** :

Since firms from period 2 onwards will prefer to compete rather than collude, the reduced normal form of the reporting game is:

	report	no report
report	$\pi - (1 - \frac{q}{2})F, \pi - (1 - \frac{q}{2})F$	$\pi - (1 - q)F, \pi - F$
no report	$\pi - F, \pi - (1 - q)F$	$\pi - \rho F, \pi - \rho F$

As long as:

$$\pi - \rho F < \pi - (1 - q)F \Rightarrow \rho > 1 - q$$

the only equilibrium is for both firms to report; otherwise, when $\rho \leq 1 - q$, the pair (no report, no report) is the Pareto dominating equilibrium.

Therefore, we have shown that reporting can indeed be triggered when the bad state of the economy occurs. For example, if there is immunity, $q = 1$, then firms prefer to report unless the probability of detection is zero. Also, as the reduction in the fine becomes more

$\frac{(\pi-\rho F)}{1-(1-\rho)\delta\theta} + \alpha(\frac{(\pi-\rho F)}{1-(1-\rho)\delta} - \frac{(\pi-\rho F)}{1-(1-\rho)\delta\theta}) > \frac{(\pi-\rho F)}{1-(1-\rho)\delta\theta} \geq 2\pi$ which holds given that we consider the case where $\delta \geq \delta_{L1}$.

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generous, it becomes more likely that firms would prefer to report. Essentially, firms find it optimal to report since the leniency program might offer a protection from fines. When $\rho > 1-q$ the outcome (no report, no report) cannot be an equilibrium since firms can increase their profits by deviating and reporting. Instead, when $\rho \leq 1-q$ firms find it optimal not to report. This happens since the probability of detection is relatively small with respect to the post leniency fine and therefore the leniency program does not offer effective protection from fines.

Lemma 2.2 (The ex post effect of leniency) *When there is no leniency program there is no desistance. The introduction of a leniency policy when there is uncertainty about the future profitability can lead to desistance when the bad state of the economy occurs, as long as* $\rho > 1-q$.

Proof: As shown above a necessary condition for reporting to arise in equilibrium is that $\rho > 1-q$. However, when $q = 0$ this inequality cannot be satisfied. When no leniency program is available, once again the revelation subgame is trivial. Firms would never have an incentive to report since this would imply they have to pay the fine with certainty.

Firms compare the probability of detection and the proportion of fine they still have to pay if they apply for leniency. Recall that the cartel activity is going to collapse from $T = 2$ onwards in any case.when the bad state of the economy materialises. If $\rho > 1-q$ firms prefer to apply for leniency to get protection from fines since otherwise they would have to pay a higher expected fine.

2.5.2 The cartel formation subgame

The question that follows is whether collusion arises ex ante. We therefore focus on the Cartel Formation subgame. We distinguish between two subcases, following Lemma 2.2.

When $\rho \leq 1-q$ firms prefer to not report in the revelation subgame.

In this scenario the firms do not report their illegal activity and they prefer to collude when:

$$V_{imp}^{CNR} = \alpha \frac{(\pi - \rho F)}{1-(1-\rho)\delta} + (1-\alpha)(\pi - \rho F) \geq 2\pi \tag{2.3}$$

$$\Rightarrow \delta \geq \frac{\pi + \rho F}{(\pi + \rho F + a(\pi - \rho F))(1-\rho)} \equiv \delta_{cnr}$$

One notes that the critical discount rate is always greater than under the case of constant profits and perfect information i.e. $\delta_{cnr} \geq \delta_{2,\theta=1}$.[19] This implies that under this scenario collusion is less likely, which is not surprising given that with probability $1-\alpha$ collusion would not be an optimal choice from the second period onwards. Also, when $a = 1$, i.e. when the high state occurs with certainty, $\delta_{cnr} = \delta_{2,\theta=1}$.

Furthermore, as shown in Lemma 2.2, when there is no leniency program firms do not report. Therefore, equation (2.3) is the Incentive Constraint (IC) of firms joining collusive agreements in such a case. Naturally, for the leniency policy to possibly have a (positive) effect on deterrence the leniency should be sufficiently high to make the incentives to report worthwhile.

When $\rho > 1-q$ firms prefer to report in the revelation subgame.

Firms would prefer to collude if:

$$V_{imp}^{CR} = \alpha\frac{(\pi-\rho F)}{1-(1-\rho)\delta} + (1-\alpha)(\pi-(1-\frac{q}{2})F) \geq 2\pi \tag{2.4}$$

$$\Rightarrow \delta \geq \frac{\pi + F(\alpha\rho + (1-\alpha)(1-\frac{q}{2}))}{(1-\rho)(2\pi-(1-\alpha)(\pi-(1-a)(\pi-(1-\frac{q}{2})F)} = \delta_{cr}(\alpha, F, q, \pi, \rho)$$

Proposition 2.1 (The ex ante effects of leniency) *The introduction of a leniency policy when there is uncertainty about future profitability affects the ex ante decision of firms to engage in collusion when $\rho > 1-q$. Greater deterrence is achieved when $1-q < \rho < 1-\frac{q}{2}$.*

Proof: One should compare the case where there is leniency policy to the case where there is no leniency program. Remember that when $q = 0$ equation (2.3) represents the relevant IC. Condition (2.4) is less likely to be satisfied when

$$V_{imp}^{CNR} = \alpha\frac{(\pi-\rho F)}{1-(1-\rho)\delta}+(1-\alpha)(\pi-\rho F) > V_{imp}^{CR} = \alpha\frac{(\pi-\rho F)}{1-(1-\rho)\delta}+(1-\alpha)(\pi-(1-\frac{q}{2})F) \geq 2\pi \Rightarrow$$

$$\rho < 1-\frac{q}{2} \tag{2.5}$$

From Lemma 2.1 we know that reporting can arise only when $\rho > 1-q$.[20] Therefore deterrence is enhanced when

$$1-q < \rho < 1-\frac{q}{2}$$

[19] $\frac{\pi+\rho F}{(\pi+\rho F+a(\pi-\rho F))(1-\rho)} \geq \frac{\pi+\rho F}{2\pi(1-\rho)} \Rightarrow (1-\alpha)(\pi-\rho F) \geq 0$ which always holds.

[20] It is trivial to note that when $\rho = 1-q$ then the introduction of leniency makes no difference on the ex ante incentive to engage in the collusive activity.

In this range of values for ρ the goal of the leniency program to place firms at a Prisoner's dilemma situation is achieved. More precisely, even if the firms would collectively prefer the outcome of (no report, no report), the possibility offered by the leniency program to report makes deviations from this outcome profitable. Given that $\rho > 1-q$, the pair (no report, no report) cannot be an equilibrium and the only Nash Equilibrium of the game is to (report, report). However, at equilibrium firms share the reduction in the fine and when $\rho < 1-\frac{q}{2}$ they become worse off. Anticipating this, in the presence of a leniency program firms will be less willing to enter illegal activities than in the case where there was no leniency policy. When the leniency program protects "adequately" the firms that report from fines (i.e. offer them lower expected fines but not rewards) then leniency can enhance deterrence and destabilise the cartel.

Lemma 2.3 *The introduction of a leniency policy can not decrease deterrence.*

Proof: We observe that condition (2.3) is stricter than condition (2.4) and therefore ex ante deterrence decreases as long as:

$$V_{imp}^{CR} > V_{imp}^{CNR} > 2\pi \Rightarrow \rho > 1 - \frac{q}{2} \tag{2.6}$$

We need to show that (2.6) cannot be satisfied.

Recall that we require that $\delta \in [\delta_{2,\theta=1}, \delta_{2,\theta<1})$. From Lemma 2.1 we have that $\delta \in [\frac{(\pi+\rho F)}{2\pi(1-\rho)}, \frac{(\pi+\rho F)}{2\pi\theta(1-\rho)})$. Also $\delta < 1$ and therefore we require that the lower bound on δ is lower than 1.

$$\frac{(\pi+\rho F)}{2\pi(1-\rho)} < 1 \Rightarrow \rho < \frac{\pi}{2\pi+F} \equiv \overline{\rho}.$$

Therefore, only for small detection rates firms will be able to sustain collusion in the good state of the economy. The upper bound of ρ where collusion can be sustained is obtained for $F = 0$, when $\overline{\rho} = \frac{1}{2}$. However, condition (2.6) can never be satisfied for such an $\overline{\rho}$, unless rewards are offered, i.e. for $q > 1$.

This result is different from the result obtained in Motta and Polo (2003) and underlines the positive effect of the leniency program in our setup. In most papers on leniency there is a trade off between higher desistance (leniency makes reporting more attractive) and lower deterrence (a decrease in the expected fine makes collusion more attractive ex ante). However, in our setup firms know with certainty whether the cartel they participate into is going to fail or not from period 2 onwards when they base their decision to report to the

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antitrust authorities. Therefore, the only effect working is a protection from fines effect that leads to a Prisoner's Dilemma situation and makes firms less willing to enter collusion ex ante. The introduction of the leniency program cannot lead to a procollusive effect since this would require that firms would need to be better off in the presence of the program. This in turn, would require the remaining part of the fine still to be paid following a leniency application, $(1-\frac{q}{2})F$, to be higher than in the case of no reporting, ρF. However, this cannot occur since it implies that the probability of detection must be higher than one half; a level at which collusion would not be sustainable in any case.

The figure below illustrates the Incentive Compatibility Constraints for the firms to participate in the cartel activity in the plane (q, ρ) for given values of π, F, α, and δ (such that it satisfies $\delta \in [\delta_{2,\theta=1}, \delta_{2,\theta<1})$). The line IC_{cnr} represents the incentive constraint for the case where there is no reporting at equilibrium. This is precisely the case if there is no leniency program. Also, as long as $\rho \leq 1-q$ (the area below the diagonal line), we have shown that it is the optimal response of the firms in the presence of a leniency program. Unsurprisingly, this line does not depend on the leniency offered and is represented as a line parallel to the $q-$axis. Above the line firms prefer to not collude whereas below the line they prefer to collude (and not report).

The thick black lines, IC_{cr} represents the IC in the case where there is a leniency program. As we showed above this coincides with line IC_{cnr} for $\rho \leq 1-q$. When $\rho > 1-q$ the IC_{cr} is an upwards sloping curve which indicates that firms are more willing to collude and report as leniency increases. In the area above the thick black lines (IC_{cr}) firms prefer not to engage in the collusive activity whereas in the area that lies between the upwards sloping part of IC_{cr} and the $\rho = 1-q$ line they prefer to collude and report if the bad state occurs.

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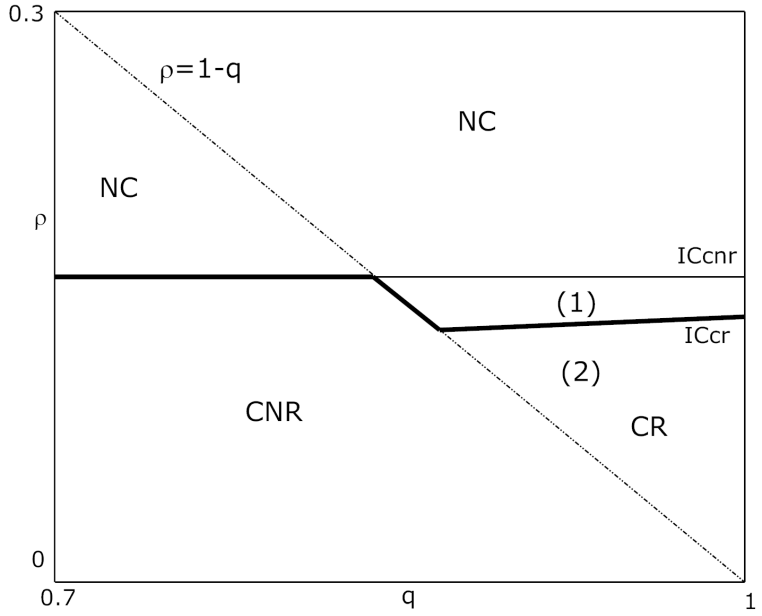

Equilibrium solutions for: $F = 1, \pi = 1$, $a = 0.5$, $\delta = 0.9$

The role of leniency can be understood from the figure. We detect two areas where the leniency policy changes the optimal response of the firms. In the presence of a leniency policy, in area (2) firms report their activity to the antitrust authorities when the bad state of the economy materialises. This is not unambiguously a positive effect since these cartels would fail in any case from period 2 onwards. Furthermore, remember that given the timing of the game the market realisation for this period has already occurred and therefore consumers have already paid the collusive prices. However, one notes that firms would collectively prefer to not report in this area. The leniency program puts the firms into a Prisoner's Dilemma situation by offering protection from fines. Anticipating this, firms would be less likely to collude ex ante. This give rise to the procompetitive effect of the leniency policy: area (1). In area (1) firms would find it optimal not to collude in the presence of a leniency program whereas in its absence they would collude. Therefore, greater deterrence is achieved.

2.5.2.1 Comparative statics

We proceed with comparative static analysis. We first consider a decrease in the probability of the high state, α. Taking the derivative of conditions (2.3) and (2.4) with respect to α we observe that the value of collusion increases and therefore firms are more willing to engage in collusive activities in the first place. This is also illustrated in the graph in Appendix 2.7.3.1 where now $a = 0.3$ instead of $a = 0.5$. This result is intuitive since when a

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is lower there is a greater probability that the low state of the economy will occur. Therefore, it is less likely that firms would prefer to collude in the first period. Also note that when we set $a = 1$ then the IC_{cnr} and IC_{cr} coincide. Hence, one notes that the difference between the vertical intercept of the two lines increases as α decreases.

The second scenario we are going to consider is a change in the proportional fine, F. As expected, collusion becomes less likely when the proportional fine increases. The effects are very similar to the case where α decreases. We observe a downward jump of the ICs. This indicates that collusion is less likely to be sustainable given that the fine that the firms are likely to pay increases. At the same time, the slope of the IC_{cr} when reporting is the preferred choice (slightly) increases. Given that the fine is relatively larger the impact of an increase in q is greater.

An increase in the discount factor makes collusion more likely since the future collusive payoffs are relatively more important today. One notes that both ICs move upwards as expected.

Finally, increasing the collusive profits shifts the ICs upwards. Trebling the profits increases the incentives to enter collusive agreements. Note that the new IC_{cr} is closer to the IC_{cnr} line and its slope is flatter. This occurs since an increase in the leniency rate would have a smaller effect on the incentive to collude when the collusive profits are greater.

2.5.2.2 Introducing a positive shock

Lemma 2.3 above predicts that there is no side effect of introducing a leniency program. We would like to investigate whether this finding is robust. We make a small modification of the model. We suppose that in the good state of the economy instead of constant profits, profits are increasing by fraction $\theta > 1$ in each period.

Lemma 2.4 *When $\theta > \frac{4\pi+F}{4\pi}$ in the good state of the economy, the introduction of a leniency program may also have an anticompetitive effect.*

Proof: We require that the lower bound of the discount factor is lower than 1:

$$\frac{(\pi + \rho F)}{2\pi\theta(1-\rho)} < 1 \Rightarrow \rho < \frac{\pi(2\theta - 1)}{2\pi + F} = \widetilde{\rho} \tag{2.7}$$

Note that equation (2.7) now depends on θ. Also from equations (2.3) and (2.4) firms would enjoy a higher payoff under reporting than under no reporting (and deterrence would decrease) when:

$$V_{imp}^{CR} > V_{imp}^{CNR} > 2\pi \Rightarrow \rho > 1 - \frac{q}{2}.$$

Therefore we require that:

$$1 - \frac{q}{2} < \widetilde{\rho}$$

$$\Rightarrow q > \frac{2\pi + F}{2\pi + F} + \frac{2\pi + F - 4\pi\theta + 2\pi}{2\pi + F}$$

This can only be satisfied when there are no rewards when:

$$\frac{2\pi + F - 4\pi\theta + 2\pi}{2\pi + F} < 0 \Rightarrow \theta > \frac{4\pi + F}{4\pi}$$

which is greater than 1.

Therefore, when

$$\theta > \frac{4\pi + F}{4\pi}$$

a third, perverse, effect arises. Since collusion would now be sustainable even for very high probability of detection, it is possible that the firms would prefer to report and enjoy the reduction in the fine offered by the leniency program. Essentially, such a leniency program would overprotect the firms from the fines, and would render the revelation game into a coordination problem where (report, report) is the Pareto optimal equilibrium. Therefore, their expected profits increase and ex ante there is a higher probability that they enter in the collusive activity. This possibility was not possible when $\theta = 1$ since in this case collusion would not be sustainable for values of the probability of detection higher than one half.

2.5.2.3 Allowing for "wait and see" strategy

Now we relax the assumption that firms need to collude in period 1 if they wish to have the possibility to collude at a later period. Therefore, we want to investigate whether firms prefer to not engage in the illegal activity until they know with certainty the state of the demand. In this case firms might employ a strategy of the type not collude in the first period and only collude (and not report) from period 2 onwards, as long as the good state of the economy materialises. Remember that since the uncertainty is resolved after the end of the first period, this strategy dominates the strategies of entering the collusive agreement, if the good state occurs, at a later period.

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The present discounted value of this strategy would be

$$V^{ws} = \alpha\delta\frac{\pi - \rho F}{1 - \delta(1-\rho)}$$

We shall consider the firms's decision in the first period and whether allowing for a wait and see strategy alters the equilibrium strategies. We analyse whether the equilibrium strategies that we identified above are preferred to the "wait and see strategy" in the cartel formation stage of the game.

When $\rho \leq 1 - q$, the firms decide not to report. The strategy collude and not report would still be optimal when

$$V_{imp}^{CNR} = \alpha\frac{(\pi - \rho F)}{1 - (1-\rho)\delta} + (1-\alpha)(\pi - \rho F) > V^{ws} = \alpha\delta\frac{\pi - \rho F}{1 - \delta(1-\rho)}$$

$$\Rightarrow \alpha(1-\delta)\frac{(\pi - \rho F)}{1 - (1-\rho)\delta} + (1-\alpha)(\pi - \rho F) > 0$$

which is always satisfied. This is intuitive since we are considering the case where it is optimal not to report even if the low state of the economy arise; therefore, one would expect that it would not be optimal to "wait and see".

When $\rho > 1 - q$, firms in the reporting game decide to report. The present value when both firms collude and then report if the bad state materialise is V_{imp}^{CR}.

If

$$V_{imp}^{CR} = \frac{\alpha(\pi - \rho F)}{1 - (1-\rho)\delta} + (1-a)(\pi - (1 - \frac{q}{2})F) \geq V^{ws} = \alpha\delta\frac{\pi - \rho F}{1 - \delta(1-\rho)}$$

$$\Rightarrow \alpha(1-\delta)\frac{\pi - \rho F}{1 - \delta(1-\rho)} + (1-a)(\pi - (1 - \frac{q}{2})F) \geq 0 \tag{2.8}$$

then allowing for such a strategy does not alter the equilibrium strategy of the firms.

One notes that a sufficient condition for the wait and see strategy not to be part of the equilibrium strategy is that $\pi - (1 - \frac{q}{2})F \geq 0$. Therefore, a sufficient condition for the above analysis to hold is that the profit level is higher than the after leniency fine ($\pi > (1 - \frac{q}{2})F$).

2.6 Conclusions

We have shown that leniency applications may be triggered when firms realise that the cartel in which they participate is failing. Therefore, in a context of imperfect information when the bad state of the economy occurs, firms will apply for leniency if the leniency policy offers effective protection from the fines. This places firms into a Prisoner's Dilemma

situation. However, this is not the only effect of the leniency policy. Indeed, anticipating that there may be desistance later on, collusion may not be achieved ex ante. Not only desistance but also deterrence is achieved.

Therefore, even in a context where leniency applications are triggered by a failing cartel and $\theta \leq 1$, leniency programs are shown to be procompetitive. Antitrust authorities should not worry about attracting only failing cartels. However, when rewards are offered reporting gives the opportunity, to the industries where collusion would collapse anyhow (i.e. in industries hit by the bad realisation of demand), to report and gain on leniency. Collusion could be made more likely ex ante since the expected cost of entering a collusive agreement decreases. Therefore, we suggest, contrary to Spagnolo (2004), that offering rewards might be counterproductive and decrease deterrence.[21]

One should note that the main results of the model hold for all values of θ.[22] As long as there are two possible states of nature where the profit level are correlated in a persistent way, firms might run into the antitrust authorities when the bad state materialises. We have shown that a third perverse effect could arise when $\theta > \frac{4\pi+F}{4\pi}$ in the good state of the economy. In such a case, leniency policy might offer firms excessive protection from fines and make firms more likely to collude ex ante. This scenario, however, is unlikely since it supposes that the probability of detection is very large. Therefore, in cases where the participation of firms in cartel activity is extremely likely, antitrust authorities should not offer reduction in fines.

Furthermore, and very importantly, one should not only focus on the specific modelling assumptions that we have made in the above analysis. The essential element is that firms know with certainty that from the next period on the cartel in which they participate is going to collapse with certainty. Then the protection from fines effect identified above would make them worse off and make collusion less likely ex ante. The cartel activity might fall in the second period for other reasons also; for example it could be that the antritrust authorities can detect perfectly the existence of a cartel agreement in the second period with probability α or that the fine might increase substantially in the second period and so on.

A possible extension of our model would be to consider a more general set of strategies. More specifically, one might want to consider what happens when following a cartel detection

[21] A complete analysis of the game when rewards are possible is necessary though. This happens since the continuation value of the game from period 2 onwards might change. Recall from Lemma 2.1 that the ineffectiveness of the leniency policy under perfect information only holds for $q \leq 1$.

[22] However for cases where in the bad state of the economy $\theta \leq \frac{1}{2}$ we cannot fall into the interesting range of the discount rate. This happens since we require that $\frac{\pi+\rho F}{2\pi\theta(1-\rho)} < 1 \Rightarrow \rho < \frac{\pi(2\theta-1)}{F+2\pi\theta}$. Since $\rho \in [0,1)$ we require that $2\theta - 1 > 0 \Rightarrow \theta > \frac{1}{2}$.

(either through investigation or though reporting) there is an intensified scrutiny in the industry for T periods (see Chen and Rey (2007)). This would allow firms to collude once again. Or, one could account for a more general set of punishment strategies.

Furthermore, one could generalise on the possible types of profit shocks that the economy could experience. One possibility that we have accounted for is that the profit levels are not correlated but demand could be high or low in each period (as in Rotemberg and Saloner (1986)). However, in such a context no leniency applications occur at equilibrium. We will try to introduce shocks in the profits that follow a Markov process and explore whether the results we have obtained carry through.

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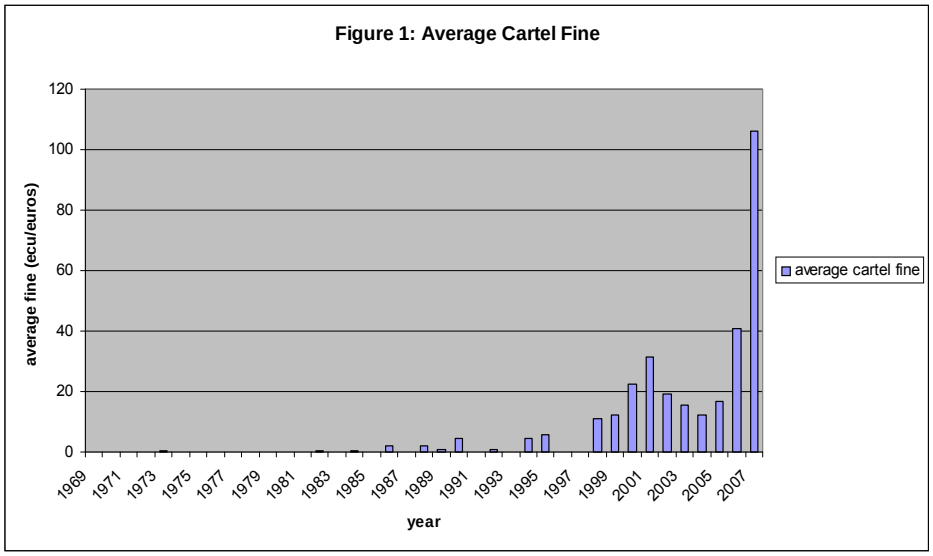
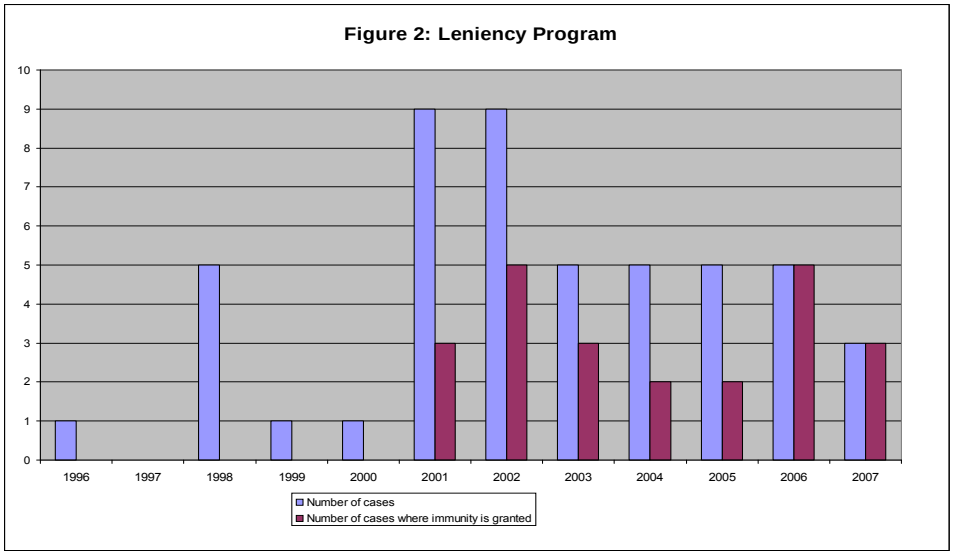
2.7 Appendix

2.7.1 Appendix 1 Average fine



2.7.2 Appendix 2 Leniency Programs



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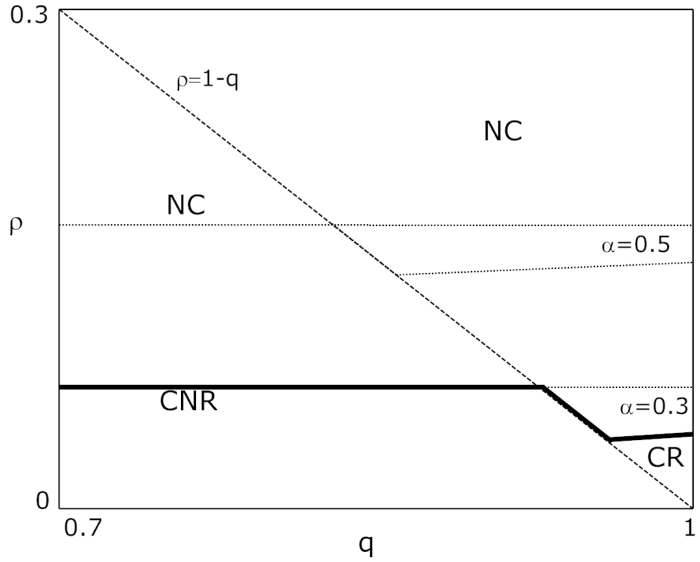
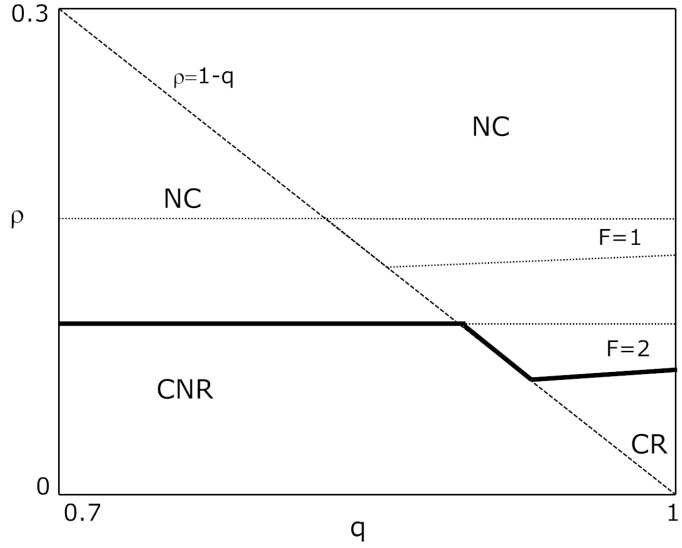
2.7.3 Appendix 3 Comparative Statics

2.7.3.1 Decreasing the probability of the high state, α



Equilibrium solutions for: $F = 1$, $\pi = 1$, $a = 0.3$, $\delta = 0.9$

2.7.3.2 Increasing the Fine, F



Equilibrium solutions for: $F = 2$, $\pi = 1$, $a = 0.5$, $\delta = 0.9$

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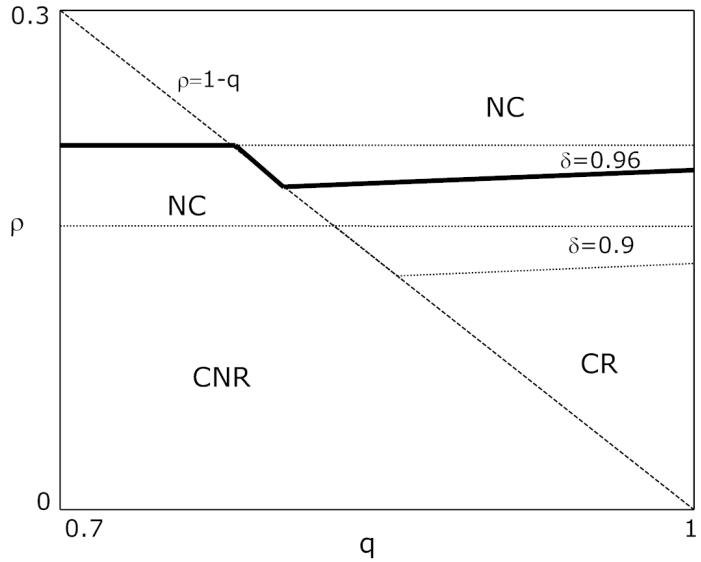
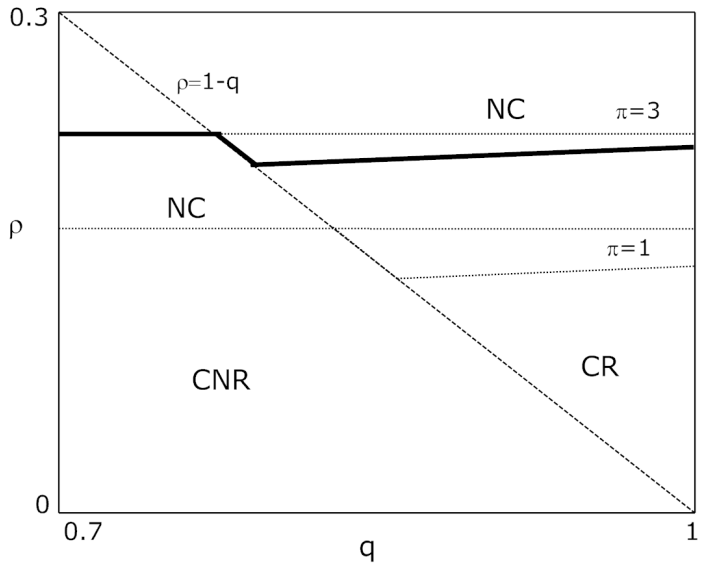
2.7.3.3 Increasing the Discount Factor, δ



Equilibrium solutions for: $F = 1$, $\pi = 1$, $a = 0.5$, $\delta = 0.96$

2.7.3.4 Increasing the Collusive Profits, π



Equilibrium solutions for: $F = 1$, $\pi = 3$, $a = 0.5$, $\delta = 0.9$

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CHAPTER 3

EUROPEAN COMMISSION ANTITRUST FINES AND DRIVERS FOR APPEAL

3.1 Introduction

There has been an increasing unease in the European Competition Policy with the high proportion of cases that are appealed following an infringement decision by the European Commission ("Commission") in the field of antitrust. The great number of appeals implies that a lot of resources of the European Commission Competition Directorate are engaged into costly litigation in front of the European Courts instead of chasing new anticompetitive practices. As Commissioner Kroes (2005) has noted: "one cartel decision triggers an average of 3 to 4 court cases... defending our decisions is an ongoing and implicit part of the process and needs to be planned for in terms of resources".[1]

This paper investigates the motivation behind the firms' decision to appeal the fining decisions adopted by the Commission for infringing article 101 and 102 of the Treaty on European Union ("article 101" and "article 102"). Why do firms appeal so frequently and doggedly against cartel decisions? How firms' propensity to appeal is affected by recent policy developments in Commission's fining policy, and most notably by the introduction of the fining Guidelines and of the leniency policy? Do firms resort to the European Courts as a response to the higher fines imposed over time? Is this behaviour due to cultural norms and an evidence of "an adversarial/litigation culture"? Are listed firms more likely to appeal? Does it depend on whether the Commission decision is an article 101 or on article 102 decision? At the same time, we analyse the degree of success of these appeals in terms of overturning Commission's decisions and reducing the fines imposed. We investigate whether this depends on political variables such as the nationality of the firms and how policy parameters may have affected the success of these appeals.

Firms have been appealing for a number of underlying reasons, ranging from procedural reasons to substantive legal and economic issues which have shaped several policy decisions of the Commission.

[1] Kroes, N. (2005), "The first hundred days", speech available at http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/05/205&format=HTML&aged=0&language=EN&guiLanguage=en

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First, as Richardson (1999) argues, during the first three decades of European Community Competition law, the Commission was criticised for the obfuscation surrounding how it determines the level of the imposed fines. In the last years, the Commission has made a concerted effort to curb the uncertainty surrounding the fining procedure. In 1998, she published Guidelines on the calculation of fines ("the 1998 Guidelines").[2] The rationale was to enhance the transparency on the determination of the level of the fines and reduce uncertainty. The Commission hoped that the 1998 Guidelines would reduce the litigation costs by laying down a number of factors for constructing the final amount of the fine. Prior to 1998, "it was readily apparent that very few decision imposing large fines escaped a challenge before the courts".[3] However, several authors note that a steady number of firms continued to resort to litigation. For example, Geradin and Henry (2005) argue that the 1998 Guidelines did not manage to improve the certainty and that "laconic conclusions by the Commission will only give impetus to increased litigation before the Courts". Carree at al (2008) claim that the increased appeals rate following the 1998 Guidelines, indicate regulatory failure with high legal costs. On the other hand, the need for higher transparency has been put in question even by Commissioner Kroes (2005). In her 100 days in office speech she said regarding the 1998 Guidelines: "In my view the guidelines are well done and have been endorsed by the Court of First Instance ("CFI"). I know they are criticised in some other quarters for lacking sufficient transparency. I take this allegation seriously; however, I have to say that I do not agree. I cannot see how allowing potential infringers to calculate the likely cost/benefit ratio of a cartel in advance will somehow contribute to a sustained policy of deterrence and zero tolerance."[4] Stephan (2007) argues that "the way the Commission determines fines is not a precise science, and the scope for appeals reducing those fines will exist for as long as the Commission exercises independently its wide discretion in their calculation. The rise in the number of cartel cases naturally entails a concomitant growth in the annual number of legal challenges". In June 2006 the European Commission adopted new fining Guidelines for companies found guilty of infringing Articles 101 or 102 ("the 2006 Guidelines"). Commissioner Kroes (2006) stated that "after more than eight years of experience, it is useful to refine the rules in the light of experience".[5] Motta (2008) suggests that "to the extent that the Courts

[2] Guidelines on the method of setting fines imposed pursuant to Article 15 (2) of Regulation No 17 and Article 65 (5) of the ECSC Treaty fines (1998)

[3] Geradin and Henry (2005)

[4] Kroes, N. (2005), "The first hundred days", speech available at http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/05/205&format=HTML &aged=0&language=EN&guiLanguage=en

[5] Kroes, N. (2006), "Commission revises Guidelines for setting fines in antitrust cases", available at http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/857&format =HTML&aged=0&language=EN&guiLanguage=en

will accept the new fining policy of the Commission, this may have the effect of making litigation less likely, freeing precious personnel time of the Commission."

From a policy perspective, the Commission has played a paramount role in antitrust policy in the European system. It is the investigator, the prosecutor and the sentencer, unlike the US system. This has raised criticisms on the constitutional notions of due process and separation of powers (see Harting and Gibbs (2005)). Therefore, one could expect that there would be a high propensity for the firms to contest the facts and the reasoning of the Commission and appeal, especially since fines have increased exponentially over time. On the other hand, one could claim that the judicial review in the European system - and the high appeal rate - is highly needed and counterbalances this lack of separation of powers. As the level of fines has increased over time, there has been a stronger need to strengthen the legal basis of the sanctioning power and to create a "more transparent decision making process on the determination of the amount" (Camilli (2006)). The Commission acknowledged the need for more transparency through the 1998 and 2006 Guidelines. In this perspective "an economic analysis of the sanctioning policy does not carry out a mere advisory role, but may provide an important tool in reviewing the consistency of the high fines imposed for the infringement." (Camilli (2006)).

The appeal rate is also likely to be affected by the type of infringement (see also the section on the legal framework below). Appellants often claim that the evidence that the Commission holds is insufficient. Especially in cartel cases, which represent an overwhelming majority of the fines imposed by the Commission in the last decade, there is a high standard of proof, that of beyond reasonable doubt. Without the discovery of an explicit agreement the establishment of guilt can become very difficult. In response to this challenge, in 1996 the Commission also introduced a leniency program for cartel activities.[6] Under this program a member of the cartel that would inform the Commission of the existence of the illegal agreement and/or provide important information would receive a reduction in the fine imposed on it. The greatest advantage of the leniency program is that it brings crucial evidence to the antitrust authorities and can therefore greatly facilitate this information gathering. The program was revised in 2002 amidst concerns that it did not create sufficient incentives for the firms to "race to the Commission".[7],[8] The leniency program might have helped the Commission over the information gathering, however, critics claim that the Commission held a large discretion over the reduction of the fines that it would allocate, and therefore did

[6] Commission Notice on the non-imposition or reduction of fines in cartel cases (1996).

[7] This happened since the initial program did not provide immunity to the first informant once the Commission had opened an investigation (see Motta and Polo (2003)).

[8] Commission Notice on Immunity from fines and reduction of fines in cartel cases (2006)

not address the obfuscation of the fine setting procedure. Geradin and Henry (2005) suggest that even the revised lenciency policy leaves room for subjective decisions and therefore for litigation. [9]

Furthermore, until the end of 2007 the European Courts had never increased the fine of the appellant firms, even if they are entitled to.[10] Even after the 1998 Guidelines, Camilli (2006) notes that "the CFI self-limited its reviewing powers for the application of the Guidelines principles within the proportionality principle. This has meant that the CFI has never been able to increase a fine imposed by the Commission". As a result, firms do not perceive that they run at risk of ending up with a higher fine by appealing at the European Courts. Furthermore, Montag (1996) argues that the high proportion of successful appeals in the 1980s and 1990s provided an incentive to firms to appeal. Thanks to the more transparent criteria set in the 2006 Guidelines, Camilli (2006) considers that "the Court could have more grounds to redress the Commission fining power, eventually raising the original amount". For the first time on December 2007 the CFI increased a fine imposed by the Commission for a violation of the European Union's competition laws (for BASF's participation in the Choline Chloride cartel).[11]

Another variable that might influence the decision of a firm to appeal might be the legal tradition in the country of the firm in question (see Cassey (2005) who study the impact of legal traditions into different aspects of competition policy). For example, firms from countries with a common law legal tradition may be more willing to appeal Commission decisions given that litigation is more important than in civil law tradition (importance of precedence and appeal). Moreover, it is often claimed that corporate structure would have an effect in the decision of firms to appeal or not. Large firms have in their possession financial resources and access to legal advice and as a result their propensity to appeal would appear to be greater. Or, it could be harder to admit to shareholders that the firm had engaged in an antitrust offense.

The second issue we investigate is the determinants of the success of the appeals. Montag (1996) claims that the high proportion of successful appeals leads to a "crisis in cartel

[9] Another related policy development is the launch in July 2008 of a settlement procedure for cartel investigations aimed at speeding up the process and avoid costly litigation. However, the firms when they sign the settlement agreement they do not make a binding commitment not to resort to the European Courts. The settlement procedure does not affect our sample since the first "hybrid" settlement case was adopted in July 2010 and therefore the settlement procedure is not further discussed in the paper http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/985&format=HTML
&aged=0&language=EN&guiLanguage=en

[10] According to art 31 of Regulation 1/2003 "the Court shall have unlimited jurisdiction...; it may cancel, reduce or increase the fine or periodic penalty imposed"

[11] Case COMP/37.533 — Choline Chloride (2004) was decided following the 1998 Guidelines.

infringement procedure". He also argues that this results in a legally discredited system. On the other hand, Harding and Gibbs (2005) argue that during the last decade the CFI increasingly checks whether the Commission has correctly applied the leniency program and the Guidelines and very rarely contradicts the principles of the Commission fining decisions. Geradin and Henry (2006) provide a detailed analysis of the parameters taken into account by the CFI when reviewing the fines imposed by the Commission. They find that the incorrect application of the leniency policy is the most common reason for a reduction in the fine following the promulgation of the 1998 Guidelines.

More generally, Harding and Gibbs (2005) argue that there is a gradual change in the role of the CFI. The CFI was originally a guarantor of regulatory rigour and fair dealing; however its main function today at least for cartel infringement decisions is that of a sentencing moderator. Besides, it has become rare that the Commission is defeated on major issues of legal principle (see Harding and Gibbs (2005)).

The structure of the paper is as follows. In the second part we present the relevant legal background and literature. In the third part we provide an empirical analysis of Commission decisions in the period 1957-2009. We analyse the motivation behind the decision of firms to appeal against the Commission decision at the European Courts and we investigate the determinants of the degree of success of these appeals. We focus on i) the effect of firm specific characteristics (whether it is listed in the stock market, country of origin), ii) case specific characteristics (article 101 versus article 102, number of recitals in the case, number of firms in the case) and iii) policy changes (fining Guidelines, leniency program) using binary and multinomial regressions. A main objective of this paper is to assess the effectiveness of the fining Guidelines in providing greater transparency in the fining policy of the European Commission.

3.2 Legal Framework and Related Literature

3.2.1 Legal Framework

The article focuses on infringement decisions of articles 101 and 102 of the TEU (ex articles 85, 86 of Treaty of Rome and 81, 82 of Treaty of Nice). Article 101 prohibits the agreements and concerted practices among undertakings that affect trade between Member States as well as restricting competition within the common market. This includes several types of economic conduct, such as horizontal or vertical agreements and joint ventures. Cartel proceedings fall into the category of horizontal agreements. Article 102 prohibits

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the abuse of dominant position of a company which includes exploitative practices (excessive pricing) and exclusionary practices (such as price squeeze, exclusive dealing, predation, trying).

Concerning the fining policy, before the 1998 Guidelines, the Commission did not adopt a unique approach, since the criteria followed were not predetermined, but explained in the decision text case by case. Following the 1998 Guidelines the basic fine was set directly for each undertaking with reference to the gravity (minor, serious, very serious) and the duration of the infringement. However, the gravity was not explicitly linked to a quantitative measure of the effect of the infringements (as in the US Sentencing Guidelines); in fact a qualitative criterion was claimed to be the most important element. Therefore, the 1998 Guidelines did not provide any clear element to link the basic fine with the infringement, "except the generic evaluation of the seriousness of the illicit behavior". Indeed the basic amount was adjusted to "take account of the effective economic capacity of offenders to cause significant damage to other operators, in particular consumers, and to set the fine at a level which ensures that it has a sufficiently deterrent effect". As a result, in practice "sometimes the fine was established with reference to the share in the European relevant market, other times with regard to the size of the undertaking." (Camilli (2006)). Geradin and Henry (2005) note that even different basic amounts were given for the same anti-competitive infringements. Furthermore, the basic amount could be increased/reduced following aggravating and attenuating circumstances. However, this was a non exhaustive list and their effect on the fine was not predetermined. Geradin and Henry (2006) conclude that "the Commission's methodology in calculating the fine fails to solve the problems identified before 1998".

The 2006 Guidelines aimed to address the shortcomings of the previous system. The 2006 Guidelines' main characteristic is the prevalence of the quantitative criterion in defining the base fine. The Commission will "take the value of the undertaking's sales of goods and services to which the infringement directly or indirectly relates in the relevant geographic area within the EEA".[12] The basic fine is set by determining an initial value related to a proportion of the value of sales to which the infringement directly or indirectly relates (upper limit of 30%) and multiplying this with the number of years of the infringement and adding a fixed component of 15-25% of the turnover of the undertaking. The basic fine is then adjusted to take into account aggravating and mitigating circumstances, the leniency notice and ability to pay. The fine cannot exceed 10% of the previous year's total turnover of the firm.

[12]Guidelines on the method of setting fines imposed pursuant to Article 23(2)(a) of Regulation No 1/2003.(2006) Official Journal C 210, p. 2-5.

3.2.2 Related literature

There is a series of articles that examines the antitrust fining decisions of the Commission. Veljanovski (2007) reviews decisions on fines imposed by the Commission on cartels over the ten year period 1998-2007. He finds that fines were appealed in 90% of the cartels detected by one or more firms and in total 98% of all fines over the period (in monetary terms) were contested in the courts. Also, he finds that the European courts have reduced the fine by an average of approximately 19%.

Geradin and Henry (2005) perform a qualitative analysis of the judicial review following the 1998 Guidelines. They find that litigation regarding the level of fines in the European courts "has not decreased, but seems on the contrary to have increased." They find that the main ground of appeal is to obtain a reduction of the fine imposed by the Commission, rather than questioning that the firm has been wrongly convicted.

Carree et al (2008) and (2010) present an analysis closer to the one undertaken in this paper. They analyse antitrust Commission decisions in the period 1957-2004. They find that a significant number of decisions has been appealed and the average reduction in the fine awarded by European Courts was approximately 50%. They find that the higher the level of fine the higher the probability of appeal. Also, article 102 decisions are more likely to be appealed. On the other hand, political or sectoral parameters do not appear to affect the appeal decision of the firms. In this paper we focus on the effect of policy parameters and most specifically of the Guidelines on the appeal decision of the firms, which was not investigated in these papers. Furthermore, we analyse the determinants of appeal outcome in terms of the aforementioned effects. In terms of methodology, we adopt a similar binary model analysis, however, clustering of observations by case is further undertaken. Also, the period under consideration is more extended (includes cases up to 2009) which allows the analysis of the decision of firms to appeal Commission decisions following both the 1998 and 2006 Commission Guidelines.

Furthermore, there is a strand of the empirical literature that examines the political economy dimension of the antitrust decisions. Duso et al (2007) find econometric evidence that there are institutional and political environment factors that could affect the result of a merger decision adopted by the European Commission. On the other hand, Ghosal and Gallo (2001) find that in the US political variables do not affect the number of antitrust cases that the Department of Justice initiated.

Bergmanm et al (2005) perform an analysis of the European Commission's merger decisions. Using a logit analysis they conclude that the Commission's authorisation decision is affected by the market shares of the merging parties as well as the entry barriers but not by

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political aspects. Lauk (2003) estimates the individual probability of an adverse finding by the German antitrust authority. She finds that the market structure plays an important role as the larger firms on the market face an increased probability of an adverse finding. Also, the higher the concentration in the market and the greater the entry barriers are the more likely the competition authority is to find certain market behaviour to be anticompetitive.

3.3 Empirical analysis

3.3.1 Data and descriptive Statistics

The dataset was constructed by consistently collecting publicly available information from the infringement decisions of the Directorate General for Competition published in the Official Journal of the European Communities and the decisions of the Court of First Instance ("CFI") and European Court of Justice ("ECJ") (available at www.curia.eu).

In the current analysis all the fining decisions of the Commission in the field of antitrust have been examined from 1957 to 2009.

There are 994 observations i.e. firms to which a Commission infringement decision with fines is addressed to, in the field of antitrust. In the early years of enforcement, the Commission took only a few infringement decisions with a fine. In July 1969 the first two such decisions were adopted (Quinine and Colourants) and 16 undertakings were fined. The highest number of undertakings that was fined in a given year was in 1994 (93) while a great number of firms was fined in 1992 (57), 2001 (60), and in 1977 and 1984 (55).

There have been in total 191 cases. The greatest number of cases were adopted in 2001 (15 cases) while 10 cases were adopted in 1998, 2002 and 2007.

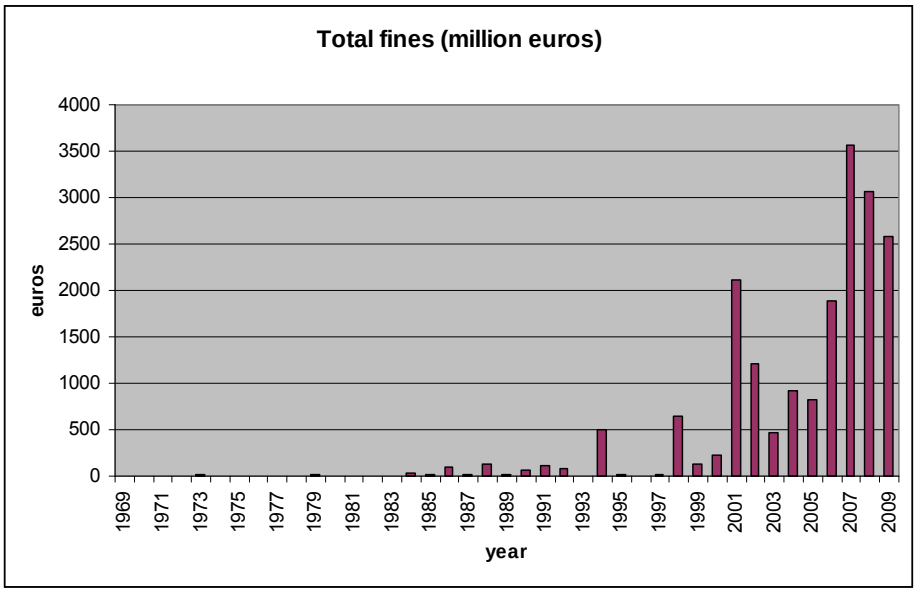
The BMW dealers' case (48 undertakings in 1977) and the Cement case (44 undertakings in 1994) are the cases with the greatest number of undertakings that was fined.

Fines Fines represent the principal tool of antitrust enforcement in the EU given that the Commission does not possess the jurisdiction to impose criminal penalties.[13] Furthermore, private damage claims have not yet gained significance despite the White Paper on private enforcement.[14]

There has been a very significant upwards trend in the fines imposed by the Commission. The graph below shows the (2007 inflation adjusted) total fine imposed on firms. It can be

[13] Art 23(5) of Regulation 1/2203 states that the Decisions should not be of criminal law nature.
[14] White paper on damages actions for breach of the EC antitrust rules, COM(2008) 165, 2.4.2008

seen that the fines have increased exponentially since the first case in 1969, reaching the highest yearly level in 2007. The first peak can be observed in 1994 which is mainly due to the high fines imposed in the Cement cartel.[15] The second peak is observed in 1998 (mainly due to the fines involved in the Trans Atlantic Conference Agreement[16]) and since 2001 fines have been consistently at high levels. The highest (nominal) fines are Intel's article 102 fine in 2009 (EUR 1060 million),[17] St Gobain's fine in 2008 (EUR 896 million) for its participation in the Carglass cartel,[18] Microsoft's article 102 fines in 2008 (EUR 889 million)[19] and 2004 (EUR 497 million),[20] the fines imposed on Eon and GDF Suez in 2009 for market sharing agreement (EUR 553 million each)[21] and the fine imposed on ThyssenKrupp in 2007 for its participation in the Elevators and Escalators cartel (EUR 480 million).[22]

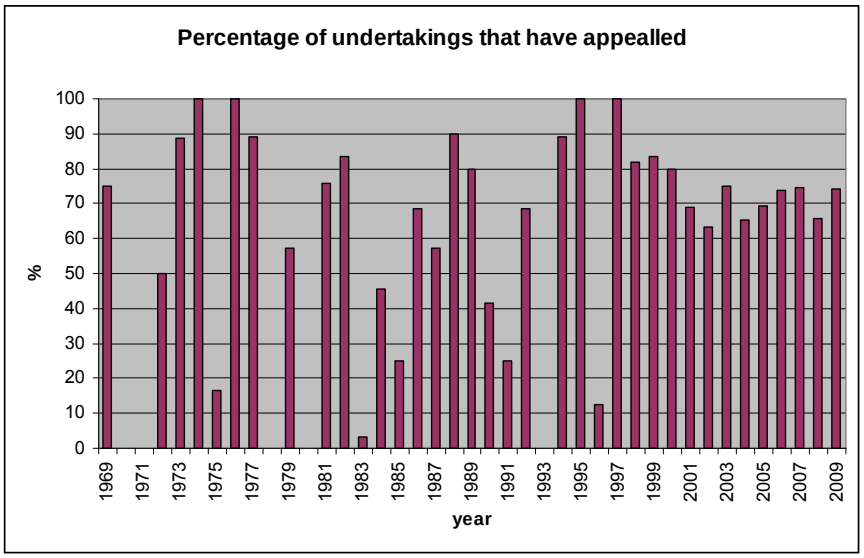


All top 10 cartel fines given by the Commission are after 2001.

Number of Appeals It is common that not all cartel participants appeal the Commission decisionm even if they are addressees of the same decision. In particular, out of the 994

[15] Case IV/33.126, IV/33.322 (1994)
[16] Case IV/35.134 (1998)
[17] Case COMP/C-3 /37.990 (2009)
[18] Case COMP/39.125 (2008)
[19] Case COMP/C-3/34.792 (2008)
[20] Case COMP/C-3/37.792 (2004)
[21] Case COMP/ 39.401 (2009)
[22] Case COMP/E-1/38.823 (2007)

undertakings in our dataset, 32 are immunity applicants and therefore no fine was imposed for their infringement (and therefore did not appeal the Commission decision). In one further case the Commission withdrew its original fine (for Bosch in the Navewa-Anseau case).[23] Out of the remaining 961 undertakings, 679 (approximately 70%) have appealed the Commission decision while 282 have not. The figure below provides information on the share of firms that has appealed a Commission fining decision per year, excluding immunity applicants. We observe that in several years all fined undertakings have appealed Commission decisions and furthermore a greater proportion of firms have appealed Commission fines post 1998.



However, while the proportion of cases that is appealed is still very high in the last decade, the percentage of undertakings that resort to European Courts following a fining decision has fallen since the introduction of the 2006 Guidelines. Excluding the undertakings for which immunity was granted, approximately 62% of the undertakings fined under the 2006 Guidelines have resorted to European Courts compared to almost 75% for the 1998 Guidelines and 69% for the undertakings fined before the introduction of the 1998 Guidelines.[24]

Reductions in Fines/Judicial review Firms fined by the Commission for antitrust infringements can resort to European Courts. Before 1988 all such cases were dealt at the European Court of Justice ("ECJ"). Following the creation of the European Court of First Instance

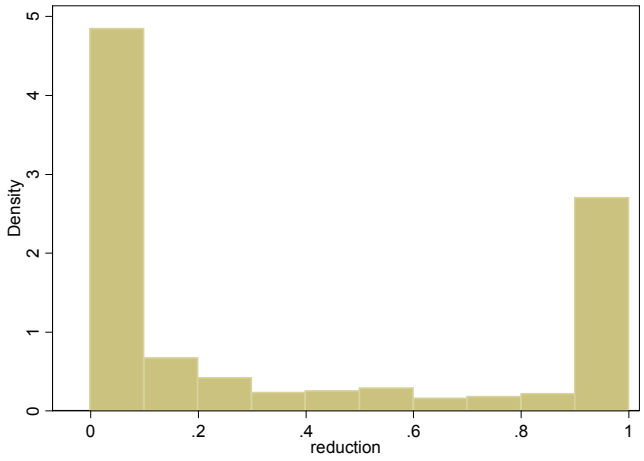
[23] Case IV/29.995 (1981)

[24] Note that these numbers are not discernible from the graph since a significant number of cases post 2006 was still decided under the 1998 Guidelines (since the Statement of Objections was dated before the introduction of the 2006 Guidelines).

("CFI") antitrust appeals were first dealt by the CFI and then undertakings can further appeal at the ECJ.[25]

We examine the outcome of the first appeal of an undertaking at the European Courts. For 129 undertakings the first appeal is still pending which includes all the cases adopted following the 2006 Guidelines.

The average reduction in the fine has been approximately 30% with around 27% of undertakings (147 undertakings) having their fine squashed by the European Courts, while 46% of the appeals were completely dismissed (i.e. no reduction in the fine was granted to 252 firms). In one case, the fine was even increased (for BASF for its participation in the Choline Chloride cartel[26] the fine was increased by 0.15%). The figure below shows the distribution of the reductions granted by the European Courts.



Following the introduction of the 1998 Guidelines, a lower number of appeals leads to zero fine (23% versus 29% before the 1998 Guidelines), while a constant share of the appeals in both periods gain no reduction in fine (approximately 46%). The average reduction in the fine following the 1998 Guidelines is approximately 30% while in the cases adopted before the Guidelines the average reduction in the fine is 40%.

Interestingly, for undertakings fined for their participation in cartels it is more likely that there is a reduction in the fine (60% receive some reduction in the fine) while only 45% of firms that allegedly infringed article 102 receive a reduction in the fine and only 25% of the addressees of an article 101 infringement decision (other than cartels) receive a reduction in the fine.

[25] The Polypropylene case (case IV/31.149 (1986)) which was adopted in 1986 was decided by the CFI.
[26] Case C/37.533 (2004)

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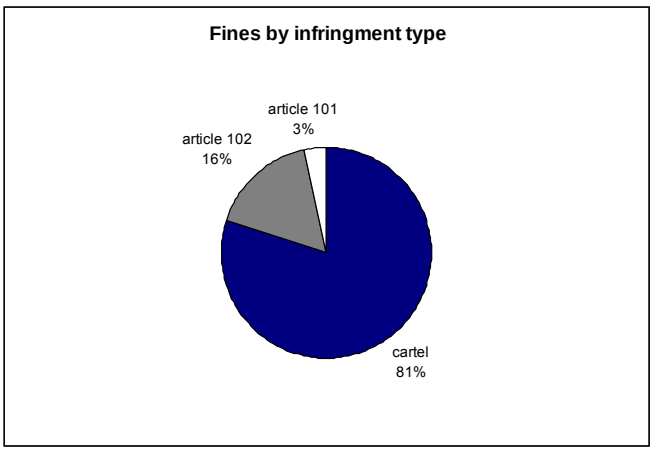
3.3.1.1 Case characteristics

Type of Antitrust infringement We further distinguish between different antitrust infringements over time. We consider a general distinction between cartel cases[27], other article 101 agreements (mostly preventing parallel import cases) and cases of abuse of dominant position (article 102). A few cases have been treated by the Commission as both cartel and article 102 cases (the French-West African shipowners' committees, European sugar industry, Trans Atlantic Conference Agreement, Cewal and the 1988 Flat Glass case)[28]. Since these decisions have both cartel and article 102 aspects we include them in the statistics as 0.5 cartel and 0.5 abuse of dominance (this concerns in total 43 undertakings).

Overall, 797 undertakings have been fined due to their participation in cartels, 164 for breaching article 101 (non cartel cases) and 76 for abuse of dominant position.

In terms of cases, there have been 106 cartel cases, 54 other article 101 cases and 36 article 102 cases. Interestingly, the vast majority of the fines have been imposed on cartel cases (almost 80%) while abuse of dominance cases represent 17% of the fines, and other article 101 cases a mere 3%.

Therefore it appears that cartel cases are fined harsher. This may reflect that in article 102 cases it is harder to establish that the firms had intent for the anticompetitive practice; however, some of the most severe fines have been imposed for article 102 infringements.



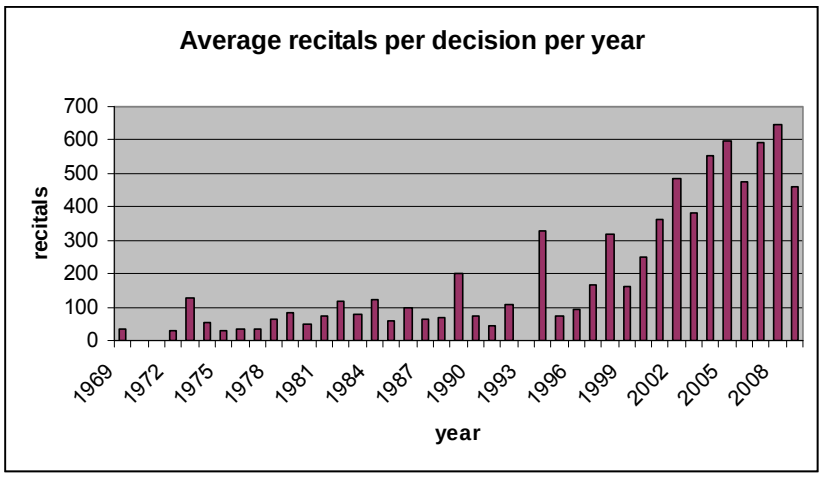
[27] The great majority of cartel cases are under article 101. However, very few cases (notably the Reinforcing bar cartel case) have been pursued under article 65 of the ESCS Treaty (Treaty establishing the European Coal and Steel Community).

[28] Cases IV/32.450 (1992), IV/26.918 (1973), IV/35.134 (1998), IV/32.448 and IV/32.450 (1992), IV/31.906 (1988) respectively.

Complexity of the case Two additional variables were used in the analysis that reflect the degree of complexity of the case. First, the number of recitals is used as an indicator of the effort placed by the Commission in explaining its analysis of the infringement at stake. Secondly, the duration of the proceedings from the Statement of Objections until the adoption of the Commission decision should also reflect the complexity of the case. A shorter time span should reflect a less complex case while a lengthy period should mirror difficulties in drafting the decision and collecting the relevant evidence.

The public version of the decision was not available for a small number of cases and therefore information on the recitals was not available for the Aluminium Fluoride cartel,[29] the Chloroprene Rubber cartel,[30] the Heat Stabilisers[31] and the Concrete reinforcing bar readoption case[32] (all cases from 2007-9). The date of the Statement of Objections was not available for the Aluminium Fluoride and the Concrete reinforcing bar readoption cartel cases.

The shortest decision (in terms of recitals) is the Hudson's Bay case[33] which contains 16 recitals while the longest is the Intel case[34] which contains 1803 recitals. Over time the average recitals per case has increased substantially with more than 400 recitals in an average decision during the last years. This is likely to be partly due to the fact that more cases over time are cartel cases which typically include more recitals. On average, cartel cases have approximately 320 recitals while article 102 cases 250 and other article 101 cases have much fewer recitals (87).

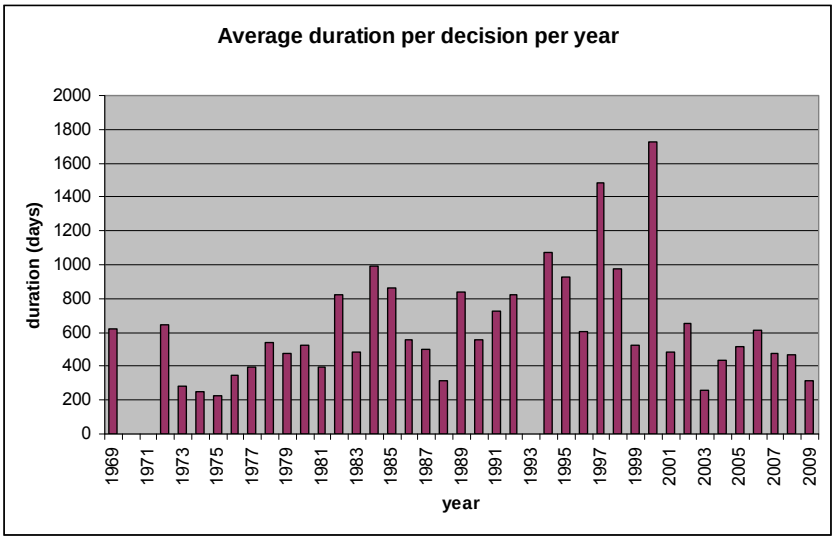


[29] Case C/39.180 (2008)
[30] Case C/38.629 (2007)
[31] Case C/38.589 (2009)
[32] Case C/37.956 (2009)
[33] Case IV/B-2/31.424 (1988)
[34] Case COMP/C-3 /37.990 (2009)

Also, the duration of the investigation has been varying significantly over time. In the 1974 General Motors Continental case[35] it took only 140 days since the Statement of Objections for the decision to be adopted. On the other hand, the Soda ash readoption case [36] in 2000 was adopted 10 years after the first Statement of Objections.

Also as a result of this case, 2000 is the year in which it has taken on average the longest to adopt a decision. However, since then we observe a reduction in the average duration of the investigations.

In terms of the different types of infringement, article 102 cases are typically the most lengthy procedures with more than 700 days of investigation between the Statement of Objections and the final decision. Cartel cases are also time consuming with approximately 670 days while other article 101 infringements take on average 500 days.

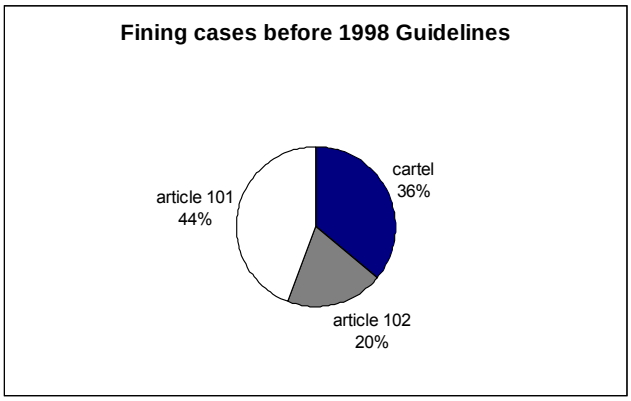


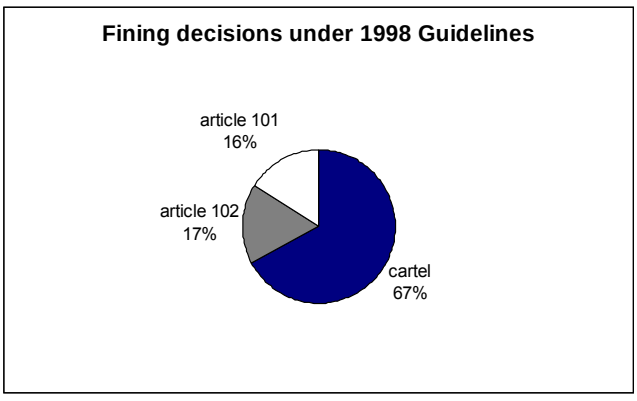
3.3.1.2 Policy developments

Guidelines 93 cases (in which 524 undertakings were involved) have been adopted before the 1998 Guidelines while 81 cases (involving 378 undertakings) follow the 1998 Guidelines. These are cases in which the Statement of Objections was sent after January 1998. Finally 17 cases, involving 92 undertakings, have been adopted following the 2006 Guidelines (cases in which the Statement of Objections was sent after September 2006).

[35] Case IV/28.851 (1974)
[36] Case COMP/33.133-D (2000)

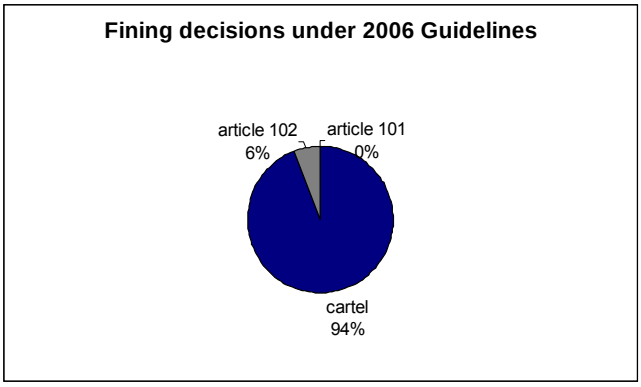
We observe that cartel cases have been rapidly increasing as a proportion of fining decisions over time, constituting over 90% of the cases in the period following the 2006 Guidelines. Article 102 cases have been relatively stable in the first two periods while only one article 102 case (the Intel case[37] which however is the case with the highest fine ever set by the Commission) has been adopted following the 2006 Guidelines. Other 101 cases have decreased very significantly; while they represented 44% of cases before the 1998 Guidelines, there is not a single decision taken in the last 3-4 years. This can be explained due to the initial (implicit) objective of competition policy of prohibiting parallel import cases in order to promote a closer economic area.





[37] Case COMP/C-3 /37.990 (2009)

DOI: 10.2870/25951



In terms of the size of fines across the different periods, a similar picture emerges -yet the pattern is less pronounced. Cartels already represented around 75% of all the fines even before the 1998 Guidelines while this ratio increased slightly above 80% with the 1998 and 2006 Guidelines. Article 102 cases' share oscillates between 15 and 20% while other article 101 infringements have always represented a very small ratio of the fines imposed (in all periods less than 5%).

Leniency program reductions Leniency applications have become a very important tool for antitrust authorities in their fight against cartels. In the EEA, there have been 32 immunity undertakings to which immunity from fines has been granted. In one further case[38] a reduction of 90% was granted, while 50% and 30% reductions were granted to 25 and 24 undertakings respectively. Leniency (i.e. some reduction in the fine) was granted to 234 undertakings; 202 such undertakings were granted leniency in a decision where the fines was calculated on the basis of the 1998 Guidelines while 31 undertakings were granted leniency in a decision adopted following the 2006 Guidelines. Under the 2006 Guidelines, there has been a relatively high number of undertakings granted immunity (9 undertakings).

Since 2001, the first year where an immunity application was granted (Brasserie de Luxemburg in the PO/Interbrew and Alken-Maes case[39]), in every year there have been undertakings granted immunity. The highest number of undertakings that were granted immunity was in 2002 and 2006, namely 5.

In the decisions that were adopted following the 1998 Guidelines, 62% involved at least one undertaking whose fine was reduced due to the leniency program. This share increases to 76% with the 2006 Guidelines.

[38] Case COMP/E-1/36 604 Citric acid
[39] Case IV/37.614/F3 (2001)

DOI: 10.2870/25951

In terms of the impact of leniency in reducing the duration of cartel proceedings, while the average duration of cartels with no leniency granted is approximately 725 days, this reduces to 587 for the cartels in which leniency reductions were granted. Furthermore, for cases in which total immunity has been granted the average duration falls drastically to 391 days. This demonstrates the importance of the leniency program in providing information that reduces the length of the proceedings and thereby saving resources for the Commission.

3.3.1.3 Firm characteristics

Listed firms The greatest number of fines has been imposed on firms that are listed on stock markets (or their parent company is listed). 53% of the firms that have been fined are listed while in terms of the fines's value this ratio is much greater and over 90%.

However, one has to recognise that this variable does not perfectly capture the size of the firms since especially in the Southern countries there are family companies that should fall into the category of "large firms" given the accessibility to financial resources.

A problem that we faced in the analysis is that mergers and acquisitions as well as bankruptcies are a common feature of the corporate structure. This constant restructuring has complicated the data collection i.e. to track whether an undertaking was listed at the time of the fining decisions. The information gathering was based on information available at the Commission decision and on the internet.

Nationality of the firm Another firm characteristic used in the analysis is the country in which the firms originate. In several cases the firms that were fined had headquarters in several countries and/or the subsidiary which was fined was not necessarily based in the same country as the parent company. Therefore, in this paper we distinguish the undertakings into those with no connection to the European Economic Area countries and those who are either headquartered in the EEA or the subsidiary that was fined was established in an EEA country. We propose this distinction since in the EEA the European Commission has extensive powers for investigation and the European Courts adjudicates for EEA law.[40]

81% of all the undertakings fined are EEA firms (or the subsidiary fined was an EEA undertaking) while the remaining are based primarily in the US, Japan and Switzerland. Among the EEA firms, German, Belgian, French, Dutch and UK undertakings are the most often fined.

[40]Note for example that a Swedish undertaking which was fined before the Swedish accession the EU is treated as a non-EEA undertaking.

Another variable of interest is whether the law of the firms' country of origin is of common or civil tradition. The great majority of the firms have civil law tradition (83%) which reflects the law in the majority of EEA countries (with the exception of UK, Ireland and Cyprus).

3.3.2 Decision to appeal before the European Courts

In this section we investigate the determinants of the probability that a firm that has been fined will resort to the European Courts. The main focus of the analysis is to control for relevant variables in order to determine the relationship between the fining Guidelines of 1998 and 2006 and the probability to appeal. Also political variables such as the nationality of the undertaking and case related variables such as the type of the infringement and the complexity of the case have interesting interpretations.

Even if each case is addressed to all the involved firms in the anticompetitive behaviour, the fines are imposed on individual participants and some undertakings may appeal a decision while other addressees of the same decision might chose not to appeal. Therefore, we consider that it is more appropriate to take as the unit of observation each individual participant rather than the case as a whole. We provide, however, information on both firm and case level.

3.3.2.1 The model

In the model the dependent variable, the decision of a firm to appeal, may take only two values i.e. it is a dummy variable representing the occurrence of an event taking value 1 when there is an appeal while 0 otherwise. The goal is to determine the relationship between the firm, case and policy characteristics and the probability of appeal.

Therefore,

$$y = \left\{ \begin{array}{c} 1 \text{ with probability } p \\ 0 \text{ with probability } 1-p \end{array} \right\}$$

A regression model is formed by parameterising the probability p to depend on a regressor vector $\mathbf{x}$ and a parameter vector β. Specifically we assume that the model takes conditional probability given by

$$p_i \equiv Pr[y_i = 1|\mathbf{x}] = F(\mathbf{x}_i'\beta)$$

where F() is a continuous strictly increasing function. The choice of the function F() determines the type of binary model. The logit model arises if F() is the cumulative distribution function (cdf) of the logistic distribution ($\Lambda(\mathbf{x}'\beta) = \frac{e^{\mathbf{x}'\beta}}{1+e^{\mathbf{x}'\beta}}$) and the probit model arises if F() is the standard normal cdf ($\Phi(\mathbf{x}'\beta) = \int_{-\infty}^{\mathbf{x}'\beta} \phi(z)dz$). We have employed both a logit and a probit model - the most commonly used parameterisations of binary models and both provide very similar results. For ease of exposition only the results of the probit model are presented (since logit results are very similar).

In the analysis, we regress the binary dependent variable on the fine imposed, on firm characteristics (listed firm, nationality (EEA and common law country)), case characteristics (recitals, duration, type of infringement) and competition policy developments (Guidelines, leniency). Given the exponential growth of the (inflation adjusted) fine imposed and of the recitals of Commission decisions over time we use the logarithm of these variables.[41] Furthermore, we cluster the observations for a given case. In such specification the standard errors allow for intragroup correlation, relaxing the usual requirement that the observations be independent. That is, the observations are independent across clusters (cases) but not necessarily within a cluster (case). We follow this approach since we expect that the error terms for the firms fined for the same case are affected by the same case specific characteristics. Furthermore, several regressants are dummy variables; whether firms are listed (default being a non listed company), have their headquarters or subsidiary fined in the EEA (non EEA as default) and whether the company or subsidiary fined have common law tradition (civil law as default), and dummies for the type of infringement (cartel and article 102) and Guidelines (Guidelines 1998 and Guidelines 2006). We introduce the leniency policy variable as the percentage reduction in the fine granted to an undertaking, and not as a dummy variable, in order to exploit the variation across the reductions in the fines granted .

We provide results both at a firm and at a case level for the probit analysis. In the latter case, the dependent variable takes the value 1 when at least one of the undertakings fined lodged an appeal while it is 0 when no undertaking appealed the Commission decision. Furthermore, firm characteristics can no longer be employed as explanatory variables; however, we introduce the average party fine as well as the number of firms in the case. The leniency variable is a dummy variable taking the value 1 when there is at least one undertaking to which a reduction in the fine has been granted and 0 otherwise.

The results of the regressions are similar in both the individual firm and the case level. The table below provides the marginal effects[42] as well as the coefficient of the probit re-

[41] However this does not affect in any way the results of the probit analysis.

[42] Marginal effects show the change in the probability for an infinitesimal change in each independent,

gressions. All variables have the expected signs, however, several variables are statistically insignificant. At the firm level, the fine imposed is always highly significant and the higher the fine the higher the probability that the firm(s) lodges an appeal (a doubling of the average fine at the levels from its mean value leads to an increase of approximately 1% point in the probability of appeal). An increased complexity of the case (both in terms of recitals and of duration of the case) leads to higher probability of appeal. The duration of the case is significant at the firm level while recitals are significant at the case level. At the firm level, a case which takes 30 days longer to be adopted increases the probability of appeal by approximately 0.5% points. Firm characteristics (nationality and listed) as well as the type of the infringement are found to be insignificant. The leniency coefficient at the firm level denotes that the higher the leniency granted to an undertaking the less likely it is that the undertaking appeals the Commission decision (a doubling of the leniency offered from the mean value leads to a 3% point reduction in the probability of appeal). Finally, as can be seen from the table, while the 1998 Guidelines's coefficient is insignificant the coefficient for the 2006 Guidelines is positive and significant. The model predicts that there is a 28% points lower probability that a firm that has been fined following the 2006 Guidelines (controlling for all the variables in the regression) resorts to the European Courts (74% prior to 2006 Guidelines and 45% following the 2006 Guidelines). This may imply that the 2006 Guidelines have provided greater transparency in the way fines are set and therefore there is lower incentive to appeal the Commission fining decisions.[43]

At the case level, the average fine, the number of firms, the recitals and the 2006 Guidelines are significant. Note that the marginal effect coefficients are larger since for the mean observation the predicted probability that at least one firm appeal is 0.82% (compared to 0.73% at the firm level).

continuous variable and reports the discrete change in the probability for dummy variables.

[43]The coefficient is significant at the 10% level; however, if one excludes from the probit analysis the dummy variable on 1998 Guidelines the coefficient is also significant at the 5% level.

	Firm		Case	
	Marginal Effect	Coefficients	Marginal Effect	Coefficients
Finedef	0.047**	0.141***	-	-
	(0.019)	(0.054)		
Listed	0.011	0.032	-	-
	(0.059)	(0.176)		
EEA	0.079	0,23	-	-
	(0.06)	-0,16		
commom law	-0.013	-0.037	-	-
	(0.062)	(0.183)		
Recitals	0.058	0.176	0.117**	0.449**
	(0.049)	(0.143)	(0.055)	(0.221)
duration	0.0002***	0.001***	0.0005	0.195
	(0.000)	(0.000)	(-0.073)	(-0.281)
cartel	-0.156	-0.468	-0.074	-0.285
	(0.128)	(0.385)	(0.088)	(0.342)
article82	-0.168	-0.462	0.092	0.399
	(0.197)	(0.508)	(0.070)	(0.350)
Guid2006	-0.282*	-0.750*	-0.420*	-1.204*
	(0.158)	(0.403)	(0.264)	(0.699)
Guid1998	-0.069	-0.205	-0.153	-0.571
	(0.097)	(0.282)	(0.117)	(0.422)
leniency	-0.006***	-0.017***	-	-
	(0.002)	(0.005)		
Average fine	-	-	0.079***	0.306***
			(0.019)	(0.070)
Leniency	-	-	0.043	0.170
			(0.111)	(0.451)
number of firms	-	-	0.019***	0.072***
			(0.007)	(0.028)
Constant		-0.275	-	-1.758*
		(0.795)		(0.902)
Observations	935	935	187	187

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.3.3 Success of Court appeals

In this section we run a multinomial model to assess how the outcome of the appeals is determined by the explanatory variables, and especially the policy variables. Multinomial models generalise bivariate analysis by allowing the discrete outcome (dependent) variable to take more than two possible values. Different multinomial models arise owing to different functional forms of the probabilities of the multinomial distribution, similar to the differences between probit and logit models in the binary case. The most often used model is the multinomial logit, which we also use in this section. We construct a new variable that reflects the extent of success of the appeals. This variable takes the value 0 when the reduction granted by the Courts is smaller than 25% (319 observations); the value of 1 when the reduction is between 25-75% (67 observations) and value of 2 when essentially the Court has slashed (or even quashed) the Commission fine (more than 75% reduction was granted to

164 firms). Note that the results are robust to different definitions of the dependent variable.

The results of the analysis are provided in the table below, which shows the multinomial logit regression coefficients as well as the odds ratio.[44] Note that the coefficients in this analysis should be interpreted relative to the reference or base category group, which is a small reduction in the fines.[45] The results of the multinomial logit analysis shows that moderate reductions in the fine are more likely than small reductions for higher fines. On the contrary, the coefficient of the fine variable for large reductions is insignificant. Interestingly, the only firm characteristic that is significant is whether the firm is EEA-related. Non EEA firms are more likely to receive a significant reduction in their fine than EEA undertakings which indicates that the Commission loses more often against non EEA undertakings at the European Courts on more serious grounds. This may indicate a political bias of the Commission against non EEA undertakings. In terms of the leniency policy, undertaking that have received higher reductions in the fine through the leniency program are less likely to be granted large reductions in their fine than small reductions. Firms that have been fined in the context of cartel and article 102 infringements are more likely to receive a large reduction rather than a small reduction in the fine. Finally, concerning the impact of the Guidelines, we first note that it is not possible to assess the relationship between the success of appeals of cases following the 2006 Guidelines, since no such appeal has been adjudicated by the Courts yet. Following the 1998 Guidelines the probability that an appeal will lead to moderate reductions in the fines is lower compared to small reductions in the fines. The effect is significant with the the relative risk for moderate relative to small reduction in the fine expected to decrease by 85%, as shown by the odds ratio coefficient (multiplied by a factor of 0.15). Therefore, the analysis seems to partly confirm that following the 1998 Guidelines the Commission is more rarely loosing appeals on substantive issues (Geradin and Henry (2005)). After controlling for the effect of the leniency policy, it appears that the Guidelines have been particularly effective in reducing the success of firms' appeals to achieve moderate reductions in their fine. This may be the original objective of the Guidelines since whether the Commission loses on substantive issues (reflected in cases where the Court reduces the fine by more than 75%) should not in principle be the cases that would be addressed by the fining Guidelines.

These results also square with the observation that fines have increased exponentially over time while the reductions granted by the Courts have been on average lower (approximately

[44] A standard interpretation of the relative risk ratio (also known as odds ratio) is as follows: for a unit change in the predictor variable, the relative risk ratio of the outcome in question relative to the reference group is expected to change by a factor of the respective parameter estimate.

[45] Only the sign of the estimated coefficients of the multinomial logit regression can be interpreted.

40% in cases before the 1998 Guidelines, falling to 30% in the period post Guidelines).

	Moderate Reduction		Large Reduction	
	Odds ratio	Coefficients	Odds ratio	Coefficients
Finedef	1.327***	0.283***	0.946	-0.056
	(0.128)	(0.097)	(0.125)	(0.132)
Listed	0.952	-0.049	1,392	0.331
	(0.489)	(0.513)	(0.726)	(0.522)
EEA	0.420	-0.868	0.274***	-1.296***
	(0.269)	(0.641)	(0.127)	(0.463)
commom law	1.207	0.188	1.417	0.349
	(0.499)	(0.413)	(0.433)	(0.306)
Recitals	1.953	0.669	1,378	0.321
	(0.937)	(0.479)	(0.539)	(0.391)
duration	1.000	0.000	1.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.001)
cartel	0.541	-0.614	5.884*	1.772*
	(0.336)	(0.620)	(5.897)	-1,002
article82	0.434	-0.835	5.062*	1.622*
	(0.355)	(0.819)	(4.882)	(0.964)
Guid1998	0.153*	-1.876*	0.616	-0.485
	(0.968)	(0.968)	(0.495)	(0.804)
leniency	0.973	-0.027	0.917***	-0.086***
	(0.023)	(0.024)	(0.027)	(0.029)
Constant		-3,152		-2,587
		(-2.262)		(2.043)
Observations	550	550	550	550

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.4 Conclusion

This article has reviewed all the Commission decisions imposing fines to undertakings for infringing antitrust rules and provides a statistical analysis of case, firm and policy characteristics. Antitrust fines have exponentially increased over time as well as the length at which the Commission analyses the case in its decision (reflected by the recitals). The Commission's enforcement priority appears to be cartel detection while there have been fewer and fewer other article 101 infringements (such as preventing parallel imports). Leniency policy has been an important tool for the Commission in this fight against cartels since in a significant proportion of cartel cases the Commission has granted full immunity to undertakings. These cartel cases also have much shorter duration periods, implying that leniency policy does not only allow the Commission to track down cartels but also to conclude more timely a case.

The main focus of the article, however, has been on the appeals placed by the undertakings fined in the context of an antitrust infringement. The appeal rate appears to be constant or even increase over time. However, when controlling for all the relevant variables,

the analysis demonstrates that especially following the 2006 Guidelines, it is less likely that firms appeal the Commission decision. One interpretation of this finding is that the Guidelines have helped improve the transparency in the fine setting thereby reducing the incentive of firms to resort to European Courts. The probability of appeal is also very significantly influenced by the level of the fine imposed and by whether the firm under question has been granted leniency.

In terms of the success of the appeals, following the introduction of the 1998 Guidelines, moderate reductions in the fines have been less likely than small reductions. Also, higher leniency granted to an undertaking leads to a lower probability that the Courts would grant a significant reduction in the fine, and non EEA firms are more likely to receive a singificant reduction in their fine by the European Courts.

There are several limitations of the analysis. A main problem relates to possibly omitted variables which might alter some of the results. However, the analysis shows that even when some variables are dropped the signs of the remaining coefficients are robust. Furthermore, the empirical analysis presented here does not establish a causal link between the dependent and independent variables which would require a background theoretical model. This is an interesting area for future research on the basis of papers by Waldfogel (1995) and Priest and Klein (1984) which study the incentives of firms to appeal.

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