

Effects of antitrust leniency on concealment effort by colluding firms

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We provide an economic analysis of the incentives created by an antitrust leniency programme, with particular attention to incentives created for effort directed at the concealment of collusion. The results point to a need for competition authorities to consider the effects of concealment when evaluating economic evidence of collusion. The results also suggest possible benefits from increasing penalties for cartels that use third-party facilitators.

Keywords: amnesty, cooperation policy, cartels, collusion

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I. Introduction

Antitrust leniency programmes in jurisdictions around the world have played an important role in allowing competition authorities to successfully prosecute major price fixing conspiracies.¹ The role of leniency in US antitrust

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¹ The Antitrust Division's Leniency Program is its most important investigative tool for detecting cartel activity. Corporations and individuals who report their cartel activity and cooperate in the Division's investigation of the cartel reported can avoid criminal conviction, fines, and prison sentences if they meet the requirements of the program.

(United States Department of Justice website <<http://www.justice.gov/atr/public/criminal/leniency.html>> accessed 22 October 2012). As Chairman of the Australian Competition and Consumer Commission (ACCC), Graeme Samuel stated that ACCC's Immunity Policy for Cartel Conduct was 'absolutely vital' in the Australian government's efforts to crack cartels and credited it with exposing potential cases at the rate of about one a month (Caron Beaton-Wells and Brent Fisse, *Australian Cartel Regulation: Law, Policy and Practice in an International Context* (CUP 2011) 379). See also Caron Beaton-Wells, 'Forks in the Road: Challenges Facing the ACCC's Immunity Policy for Cartel Conduct: Part 1' (2008) 16 *Comp & Con L J* 71–113; Caron Beaton-Wells 'Forks in the Road: Challenges Facing the ACCC's Immunity Policy for Cartel Conduct: Part 2' (2008) 16 *Comp & Con L J* 246–85; and Wouter PJ Wils, 'Leniency in Antitrust Enforcement: Theory and Practice' (2007) 30 *World*

enforcement has been particularly prominent since the change to the US anti-trust leniency programme in 1993 to allow firms to apply for leniency even after the DoJ has started an investigation if certain conditions are met.² Similar changes were made to the EU antitrust leniency programme in 2002 to allow for leniency after an investigation has been opened.³ According to Motta and Polo, 'The key mechanism of leniency programs is the rule that allows firms to receive fine reductions even after an investigation is opened.'⁴ According to Bloom, roughly half of the leniency applications received by the EC follow leniency applications in the USA.⁵

The European Commission (EC) decisions in cartel cases typically describe the leniency discounts received by the cartel firms, and in many cases one firm receives a 100 per cent reduction in its fine as a result of the leniency programme. The EC decisions in cartel cases for 2001–12 show that a firm received a 100 per cent reduction in its fine as a result of leniency in 55 (54 per cent) of the 101 products in which firms were prosecuted.⁶

Comp 25–64. For a description of the evolution of USA and EC leniency programmes, see Wouter PJ Wils, *Efficiency and Justice in European Antitrust Enforcement* (Hart Publishing 2008) ch 5.

² 'A company will qualify for leniency even after the Division has received information about the illegal antitrust activity, whether this is before or after an investigation is formally opened, if the following [seven] conditions are met:' (Scott D Hammond and Belinda A Barnett, 'Frequently Asked Questions Regarding the Antitrust Division's Leniency Program and Model Leniency Letters' (2008) US Department of Justice, <<http://www.justice.gov/atr/public/criminal/239583.pdf>> accessed 15 July 2014, p 5).

³ See Giancarlo Spagnolo, 'Leniency and Whistleblowers in Antitrust' in P Buccirosi (ed), *Handbook of Antitrust Economics* (MIT Press 2008) ch 7, s 7.2.2; and Andreas Stephan, 'An Empirical Assessment of the European Leniency Notice' (2009) 5 J Comp L & Econ 537–61, p 554 and Table 4. In Australia, leniency applications are permitted until the ACCC has received written legal advice that it has sufficient evidence to commence proceedings in the case.

⁴ Massimo Motta and Michele Polo, 'Leniency Programs and Cartel Prosecution' (2003) 21 J Indus Orga 347–79, 349.

⁵ One important factor that is likely to lead to an overestimate of the success of the EC leniency program is where applications to the Commission either followed on from those to the US Department of Justice (DOJ) or were simultaneous. The prime aim of any applicant is normally to avoid US criminal sanctions. But once a US investigation is stimulated by an amnesty application, other authorities will start investigations as they become aware at some stage of the US one. Hence applications need to be made simultaneously to other authorities or as soon as possible after one to the DOJ. It is the US powers rather than the EC (or other jurisdiction) powers which drive these applications. However, if the applicants could not secure leniency in the EC as well as the US it is highly likely that a significant proportion of them would not apply for US amnesty as they would not be able to avoid heavy EC fines. In approaching half of the EC cases from 2000 there was a prior or simultaneous application for amnesty under the US program.

(Margaret Bloom, 'Despite Its Great Success, the EC Leniency Program Faces Great Challenges' in Claus-Dieter Ehlermann and Isabela Atanasiu (ed), *European Competition Law Annual 2006: Enforcement of Prohibition of Cartels* (Hart Publishing 2007) 8–9).

An examination of European Commission decisions in cartel cases for 2001–12 shows that there were no leniency applications made until after the investigation in 18 (28%) of the 68 cases for which the EC decisions allow us to identify the timing of the leniency applications relative to the date of the EC investigation (dawn raids) and for which at least one firm received some reduction in its fine due to leniency.

⁶ Some EC decisions apply to more than one product. For example, the EC decision in *Vitamins* covers multiple vitamin products, with a separate application of the leniency programme for each product. EC decisions in cartel cases from 2001 to the present are available at <<http://ec.europa.eu/competition/cartels/cases/cases.html>> accessed 15 July 2014.

Cases in which a firm received a 100% fine reduction		
Airfreight	Elevators and escalators	Methylglucamine
Aluminium Fluoride	Exotic fruit (bananas)	Monochloroacetic Acid
Animal Feed Phosphates	Fine art Auction Houses	Mountings for windows and window-doors
Bananas	Fittings	Needles
Bathroom fittings & fixtures	Food flavour enhancers	Netherlands beer market
Bitumen Nederland	Freight forwarding	Organic peroxide
Bitumen Spain	Gas insulated switchgear	Power transformers
Calcium carbide	Hard haberdashery: fasteners	Prestressing steel
Candle waxes	Heat stabilisers	Refrigeration compressors
Carbonless paper	Hydrogen peroxide	Rubber chemicals
Chloroprene rubber	Industrial bags	Sodium Chlorate
Choline chloride	LCD	Sorbates
Consumer Detergents	Luxembourg brewing industry	Specialty graphite
Copper plumbing tubes	Marine hoses	Synthetic rubber (BR/ESBR)
CRT glass bulbs	Methacrylates	Vitamins
DRAM	Methionine	Water management products
Electrical and mechanical carbon and graphite products		

Figure 1. EC cartel cases 2001–12 with a firm receiving a 100% fine reduction based on the leniency programme.

As shown in Fig. 1 (from Marx, Mezzetti, and Marshall), a firm received a 100 per cent leniency discount on its fine in a large number of cartels involving a wide variety of products and services.⁷

The EC decisions typically report the ‘basic amount’ of the fine for each cartel firms, including a firm that ultimately receives a 100 per cent discount on that fine and so pays nothing. The basic amount reflects, among other things, the firm’s relevant sales during the infringement period, not to exceed 10 per cent of the firm’s world-wide turnover in the preceding year.⁸ Thus, the relevant values of the basic amounts of the fines for the firms in a cartel provide a measure of the relative sizes of those firms as related to the product at issue. By examining the basic amount of the fine for firms receiving a 100 per cent leniency discount relative to those of its co-conspirators, we can get a sense for the typical size of the primary leniency applicant relative to the other firms in the cartel.

⁷ Leslie M Marx, Claudio Mezzetti and Robert C Marshall, ‘Antitrust Leniency with Multi-Product Colluders’ (2014) Working Paper, Duke University <<https://faculty.fuqua.duke.edu/~marx/bio/papers/antitrustleniency.pdf>> accessed 15 July 2014.

⁸ According to the Guidelines on fines, the basic amount of the fine consists, first, of an amount of between 0% and 30% of a company’s relevant sales during the infringement period, according to the degree of gravity of the infringement. Second, an additional amount of between 15% and 25% of the value of a company’s relevant sales can be added, irrespective of duration, in order to deter horizontal price fixing agreements (the so-called ‘entry fee’). The resulting basic amount can then be increased or reduced for each company if either aggravating or mitigating circumstances are retained. Should the ensuing amount of the fine exceed 10% of the world-wide turnover of an undertaking concerned in the preceding business year, the fine must be reduced to that percentage, pursuant to Article 23 of Regulation (EC) No 1/2003. That amount can still be reduced in accordance with the Leniency Notice, where applicable.

(EC Decision in LCD (*Liquid Crystal Displays*), para 378.)

successfully prosecuted. We rely on an adaptation of the model of leniency in Marx, Mezzetti, and Marshall, but we endogenize the probability with which cartels are successfully prosecuted by allowing colluding firms to choose the level of concealment effort.

We consider concealment activity that reduces the probability that the competition authority acquires evidence of collusion and so starts an investigation, as well as concealment activity that reduces the probability that an internal investigation at an individual firm produces sufficient evidence to support a leniency application.

For example, in order to reduce the probability that a competition authority starts an investigation, firms might expend additional effort coordinating their claimed justifications for price increases or arranging their conduct to more closely resemble non-collusive conduct.¹⁰

To reduce the probability that an individual firm can produce sufficient evidence through internal investigations to support a leniency application, colluding firms might make changes to the firm's organizational chart to limit the number of individuals who must know about the collusion or expend resources to engage a third-party facilitator for the cartel that could manage incriminating evidence.¹¹ For example, the EC Decision in *Organic Peroxides*, states that the cartel engaged the consulting firm AC Treuhand, which advised the cartel members at meetings 'on what measures to take to avoid detection of these arrangements' bearing on Europe'.¹² In addition, AC Treuhand maintained certain documents at the premises of the consulting firm AC Treuhand in Switzerland,¹³ and they worked with the cartel firms to take steps to avoid traces of cartel meetings in firm records.¹⁴ As described by Harding in a discussion of the role of AC Treuhand in the organic peroxides cartel:

Large scale business cartels are complex and sophisticated organisations which require careful planning and management. The cartel will be constructed around a

¹⁰ On the coordination of justifications for collusive price increases, see the EC Decisions in *Electrical and Mechanical Carbon and Graphite Products* (paras 101, 108, 111, 245), *Cartonboard* (para 19), and *Amino Acids* (para 164). On cartel efforts to mimic non-collusive oligopoly behaviour, see the EC Decisions in *Cartonboard* (para 73) and *Vitamins* (para 204).

¹¹ The potential role of outside consultants in facilitating collusion was recognized by Lisa Phelan, Chief of the National Criminal Enforcement Section of the DoJ's Antitrust Division, in her advice while speaking on an ABA panel on corporate criminal antitrust conduct to: 'Take a look at the consultants that your companies might have and see what are these fees and what are they about and what are they doing for us. We have seen fees going for illegal, illegitimate conduct.' ('Companies should monitor consultants, conference attendance to prevent price-fixing, official says', MLex, 26 March 2014.)

¹² EC Decision in *Organic Peroxides* (para 92(j)).

¹³ '[AC Treuhand] produced, distributed and recollected the so called "pink" and "red" papers with the agreed market shares which were, because of their colour, easily distinguishable from other meeting documents and were not allowed to be taken outside the AC Treuhand premises.' (ibid para 92(b).) In addition, although AC Treuhand later released certain documents to a cartel member, '[AC Treuhand] stored the original agreement from 1971 and other relevant documents concerning the agreement in its safe.' (ibid para 92(f).)

¹⁴ '[AC Treuhand] reimbursed the travel expenses of the participants, in order to avoid traces of these meetings in the companies' accounts.' (n 12) para 92(d).)

sequence of communications and perhaps meetings which naturally have to be covert in nature and managed in a careful way regarding evidence.¹⁵

One would expect this type of arrangement to reduce the ability of cartel firms to be able to produce sufficient evidence to qualify for leniency.¹⁶

We show that cartels optimally respond to the introduction of a leniency programme by increasing both types of concealment effort, thereby mitigating the effects of the leniency programme. Concealment effort directed at reducing the probability of an investigation by the competition authority potentially reduces the profitability of collusion and so may provide benefits to consumers even if the cartel is not detected. However, concealment effort directed at reducing the probability that an individual cartel member has access to evidence sufficient to support a leniency application potentially contributes to the use of professional cartel facilitators and likely generates greater consumer harm.

In Section II, we briefly discuss related literature. In Section III, we provide background information on the role that professional cartel facilitators have played in prosecuted cartels. In Section IV, we present the basic leniency model, which is based on the model of Marx, Mezzetti, and Marshall. In Section V, we discuss the model's implications for the economic incentives created by leniency. Section VI concludes.

II. Literature

There is a large economics literature on antitrust leniency.¹⁷ Many papers have studied the problem of self-enforcement of a cartel structure, using repeated games models.¹⁸ In these models, collusive behaviour can be supported without

¹⁵ C Harding, 'Capturing the Cartel's Friends: Cartel Facilitation and the Idea of Joint Criminal Enterprise' (2009) 34 Eur L Rev 298–309, p 300.

¹⁶ Despite precautions, in *Organic Peroxides*, there were leniency applications:

[Peroxid Chemie] and Laporte [later Degussa] provided in their submission the original of the initial main agreement of 1971, which they obtained from AC Treuhand while preparing the leniency application. It was printed on pink paper, as were other confidential cartel documents which were not allowed to be taken out of the premises of AC Treuhand. ((n 12) para 83.)

¹⁷ For surveys, see Patrick Rey, 'Towards a Theory of competition Policy' in M Dewatripont, LP Hansen and SJ Turnovsky (eds), *Advances in Economics and Econometrics: Theory and Applications* (CUP 2003); and Spagnolo (n 3). See also Wils, *Efficiency and Justice* (n 1) ch 5.

¹⁸ See, for example, Zhijun Chen and Patrick Rey, 'On the Design of Leniency Programs' (2013) 56 J L & Econ 917–57; Jay Pil Choi and Heiko Gerlach, 'Multi-Market Collusion with Demand Linkages and Antitrust Enforcement' (2013) 61 J Industrial Economics 987–1022; Yassine Lefouili and Catherine Roux, 'Leniency Programs for Multimarket Firms: The Effect of Amnesty Plus on Cartel Formation' (2012) 30 Intl J Indus Org 624–40; Joseph E Harrington, Jr, 'Optimal Corporate Leniency Programs' (2008) 56 J Indus Eco 215–46; Joe Chen and Joseph E Harrington, Jr, 'The Impact of the Corporate Leniency Program on Cartel Formation and the Cartel Price Path' in Vivek Ghosal and Johan Stennek (eds), *The Political Economy of Antitrust* (Elsevier 2007) 59–80; Cécile Aubert, Patrick Rey and William E Kovacic, 'The Impact of Leniency and Whistle-blowing Programs on Cartels' (2006) 24 Intl J Indus Org 1241–66; Paolo Buccirossi and Giancarlo Spagnolo, 'Optimal Fines in the Era of Whistleblowers: Should Price Fixers Still Go to Prison?' (2005) Lear Research Paper No 05-01 <<http://www.lear-lab.it/Publications/Lear-RP-05-01.pdf>> accessed 15 July 2014; Paolo Buccirossi and Giancarlo Spagnolo, 'Leniency Policies and Illegal Transactions' (2006) 90 J Pub Eco 1281–97; Giancarlo Spagnolo, 'Divide et Impera: Optimal Leniency Programs' (2004) CEPR Discussion Paper No 4840 <<http://www.cepr.org/>> accessed 15 July 2014; Motta

communication and interfirm transactions.¹⁹ Harrington considers a cartel that has ended, so deviations from the collusive agreement are no longer an issue, but the threat remains that firms might disclose the cartel to authorities and apply for leniency.²⁰ These papers suggest that a leniency programme makes it more difficult for firms to support collusion, although they recognize that to the extent that leniency programmes reduce the fines firms expect to pay, they may reduce deterrence.

Chen and Rey (2012), Chen and Harrington (2007), Spagnolo (2004), and Motta and Polo raise the concern that generous leniency programmes may be exploited by cartels; in particular, they consider the potential benefits to a cartel from the strategic use of leniency in order to obtain reduced fines. There are also empirical studies,²¹ and economic experiments related to leniency.²²

In contrast to the existing literature, we use a modelling approach based on the economics of global games to focus on the coordination game among colluding firms that is induced by the existence of a leniency programme. The basic coordination problem is that if your co-conspirator is going to apply for leniency, then you have an incentive to try to beat him to it, but if your co-conspirator is not going to apply for leniency, then you may be able to avoid penalties altogether if you refrain from applying for leniency. In this case, you must trade off the possibility of a high payoff, in the event that the absence of a leniency applicant means that you are not penalized, with the possibility of a low payoff, in the event that you are successfully prosecuted without the protection of leniency. Coordination games like this typically have multiple equilibria, but the economic theory of global games allows us to identify a unique equilibrium based on the game theoretic notion of ‘risk dominance’, which incorporates both the level of payoffs and riskiness of payoffs to select among equilibria.²³

and Polo (n 4); and Giancarlo Spagnolo, ‘Self-Defeating Antitrust Laws: How Leniency Programs Solve Bertrand’s Paradox and Enforce Collusion in Auctions’ (2000) FEEM Working Paper 52.00, Fondazione Eni Enrico Mattei <<http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm>> accessed 15 July 2014.

¹⁹ For a discussion of the role of communication in supporting collusion, see Edward J Green, Robert C Marshall and Leslie M Marx, ‘Tacit Collusion in Oligopoly’ forthcoming in Roger D. Blair and D. Daniel Sokol eds., *Oxford Handbook on International Antitrust Economics*, Oxford University Press.

²⁰ Joseph E Harrington, Jr, ‘Corporate Leniency Programs when Firms have Private Information: The Push of Prosecution and the Pull of Pre-emption’ (2013) 61 *J Indus Econ* 1–27.

²¹ Eg see Daniel D Sokol, ‘Cartels, Corporate Compliance and What Practitioners Really Think About Enforcement’ (2012) 78 *Antitrust L J* 201–40; Jun Zhou, ‘Evaluating Leniency with Missing Information on Undetected Cartels: Exploring Time-Varying Policy Impacts on Cartel Duration’ (2013) SSRN Working <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1985816> accessed 15 July 2014; Nathan H Miller, ‘Strategic Leniency and Cartel Enforcement’ (2009) 99 *Am Econ Rev* 750–68; and Stephan (n 3).

²² Eg see Maria Bigoni and others, ‘Trust, Leniency and Deterrence: Evidence from an Antitrust Experiment’ (2012) Working Paper, University of Bologna <http://ibe.eller.arizona.edu/docs/papers/2013/bigoni_Trust_Leniency_Deterrence_2012_10_30.pdf> accessed 15 July 2014; Maria Bigoni and others, ‘Fines, Leniency, and Rewards in Antitrust’ (2012) 43 *RAND J Econ* 368–90; and Jeroen Hinloopen and Adriaan R Soetevent, ‘Laboratory Evidence on the Effectiveness of Corporate Leniency Programs’ (2008) 39 *RAND J Econ* 607–16.

²³ The economic theory of global games shows that often the existence of multiple equilibria relies on common knowledge of payoffs, but that if players have private information, the equilibrium is unique. See Hans Carlsson and Eric van Damme, ‘Global Games and Equilibrium Selection’ (1993) 61 *Econometrica* 989–1018; Hans Carlsson and Eric van Damme, ‘Equilibrium Selection in Stag Hunt Games’ in Kenneth

III. Third-party cartel facilitators

It is not uncommon for cartels to engage third-party facilitators in order to manage and conceal their conduct.²⁴ In this section, we provide some background on the role that consulting firms have played in facilitating collusion and how that has been viewed by antitrust authorities by reviewing elements of three cases: *Italian Cast Glass*, *Organic Peroxides*, and *Marine Hoses*.

Italian cast glass

The cartel described in the EC Decision in *Italian Cast Glass* engaged the consulting firm Fides-Unione Fiduciaria SpA, Milan (Fides) to facilitate cartel communication and to perform audits to ensure that reports made by the colluding firms to Fides were accurate and in compliance with the cartel agreement.²⁵ The decision suggests that the colluding firms used bilateral communication between individual cartel members and Fides:

[T]he manufacturers in question decided not to exchange directly the statistical data and other information relating to their manufacturing and marketing policies, but to do so through a third party, namely Fides, so ensuring that the information to be provided by the participants on the basis of the memorandum of 30 March 1976 was objective.... The agreement... requires the undertakings concerned to exchange, through Fides, commercial information on amounts sold and prices for each type of product, information which is not normally shared between competitors. The verification of compliance with the sales quotas for cast glass on the Italian market similarly contributed to the realization of a restriction of competition.²⁶

The decision argues that Fides qualified as an ‘undertaking’ within the meaning of Article 85(1) because ‘it is a company which carries on an economic activity complementary to those of the companies [engaged in collusion] . . . and which, in so doing, effectively took part in a practice which restricted competition within the meaning of Article 85 (1)’.²⁷ The EC further argues that, ‘it must be borne in mind that Fides enabled and consciously assisted the implementation of the restrictions of competition which were the very purpose of the agreements, and consequently it is jointly responsible for the resulting restrictive effects’.²⁸

Binmore, Alan Kirman and Piero Tani (eds), *Frontiers of Game Theory* (MIT Press 1993) 237–53; and Stephen Morris and Hyun Song Shin, ‘Global Games: Theory and Applications’ in M Dewatripont, L Hansen and S Turnovsky (eds), *Advances in Economics and Econometrics, The Eighth World Congress* (CUP 2002) 56–114.

²⁴ On the third-party facilitation of cartels, see Robert C Marshall and Leslie M Marx, *The Economics of Collusion: Cartels and Bidding Rings* (MIT Press 2012) ch 6.6.

²⁵ Decision 80/1334 relating to a proceeding under art 85 of the EEC Treaty (IV/29.869-Italian Cast Glass) [1980] OJ L383/19.

²⁶ *ibid* II.A.4.

²⁷ *ibid* II.A.2.

²⁸ *ibid* II.A.4.

In this case, no fines were levied against the firms, but the EC decision makes the argument that if there had been fines, then fines for Fides would also have been appropriate.²⁹ Fides was ordered to cease providing support to the cartel firms.³⁰

Organic peroxides

The cartel described in the EC Decision in *Organic Peroxides* engaged the consulting firm AC Treuhand AG (AC Treuhand) to facilitate cartel communication, perform audits, manage cartel documents, advise the cartel on how to avoid detection, and provide other services.³¹ The decision provides a 15-point list detailing the services provided by AC Treuhand for the cartel.³²

The decision indicates that this was an ongoing business model for AC Treuhand, saying that, ‘During the seventies, eighties and in the early nineties AC Treuhand’s predecessor company Fides performed similar tasks. The person involved since at least the eighties was the same, namely [. . .].’³³

The EC recognized that AC Treuhand played a key role in the operation of the cartel, saying that ‘Treuhand’s role was . . . to ensure the effective operation of the cartel, while also working to ensure its secret character, and as such was consciously law-defying’.³⁴

²⁹ *ibid* II.B.4.

³⁰ J Kallaugher and A Weitbrecht, ‘Developments under the Treaty on the Functioning of the European Union, Articles 101 and 102, in 2008/2009’ (2010) 31 *Eur Comp L Rev* 307–17, p 317.

³¹ As noted in the EC decision in *Organic Peroxides* (para 20), ‘AC Treuhand is the result of a 1993 management-buyout of the division offering association-management within a company called Fides Trust AG.’ See the EC decision in *Cartonboard* at para 37 on the role Fides Treuhandgesellschaft played in facilitating that cartel. See s 4.3 of the EC decision in *Heat Stabilisers* for the role that AC-Treuhand AG played in facilitating that cartel.

³² AC Treuhand: (a) organised meetings of the members of the agreement, often in Zurich; (b) produced, distributed and re-collected the so called ‘pink’ and ‘red’ papers with the agreed market shares which were, because of their colour, easily distinguishable from other meeting documents and were not allowed to be taken outside the AC Treuhand premises (see details below); (c) calculated the ‘pluses and minuses’, i.e., the deviations from the agreed market shares, which were used for compensations; (d) reimbursed the travel expenses of the participants, in order to avoid traces of these meetings in the companies’ accounts; (e) collected data on OP sales and provided the participants with the relevant statistics; (f) stored the original agreement from 1971 and other relevant documents concerning the agreement in its safe and handed them over to PC [Peroxid Chemie GmbH & Co. KG, Pullach]; (g) acted as a moderator in case of tensions between the members of the agreement and encouraged the parties to find compromises. AC Treuhand would try to stimulate the parties to work together and reach an agreement ‘*The message from AC Treuhand was that it would get worse for the participants if they discontinued the discussions*’; (h) was actively involved in reshaping the arrangement among producers in 1998 during a bilateral meeting in Amersfoort between Akzo representatives and . . . of AC Treuhand. During this bilateral meeting a solution aimed at meeting Atochem’s demand was developed. The solution consisted of a proposal of AC Treuhand for the new quotas; (i) AC Treuhand advised the parties whether or not to allow other participants into the agreement; (j) instructed all participants on the legal dangers of parts of these meetings and on what measures to take to avoid detection of these arrangements’ bearing on Europe; (k) participated mainly the ‘summit’ meetings but at least at one instance in the nineties attended also a working group meeting; (l) according to Akzo chaired at least some of the meetings, (AC Treuhand sees itself his [*sic*] in its reply to the SO not as chairman but as moderator); (m) was aware of the Spanish sub arrangement and was asked to calculate the deviation between agreed quotas and effective sales in Spain (n) organised the auditing of the data submitted by the parties (o) calculated the new quotas after the acquisition and integration of competitors in the agreement. (See n 12 para 92, emphasis in the original.)

³³ See n 12 para 93.

³⁴ See Harding (n 15) 301.

Confirmation of the ability of the EC to fine a cartel facilitator such as AC Treuhand followed from the *Organic Peroxides* case:

A judgment of the CFI of July 8, 2008³⁵ addressed for the first time the question whether a company which facilitates the operation of a cartel infringes art.101(1) TFEU and can be fined for such infringement.... The Commission had found that AC-Treuhand had infringed art.81 EC along with the actual participants in the cartel, and had imposed on it a symbolic fine of €1,000 since this case marked the first occasion that a cartel facilitator was actually fined. In a previous Decision, the Commission had only ordered a consultancy to cease the support of a cartel.³⁶

Harding provides additional discussion of the court decision and the understanding of the basis for the legal liability of third-party cartel facilitators that it provides:

The Court stated in particular that, “it is sufficient for the Commission to show that the undertaking concerned attended meetings at which anticompetitive agreements were concluded, without manifesting its opposition to such meetings, to prove to the requisite legal standard that that undertaking participated in the cartel... Where an undertaking tacitly approves an unlawful initiative, without publicly distancing itself from the content of that initiative or reporting it to the administrative authorities, the effect of its behaviour is to encourage the continuation of the infringement and to compromise its discovery. It thereby engages in a passive form of participation in the infringement.”³⁷ This provides a statement of the legal basis for what might be termed “facilitator liability”, and confirms that the net of liability extends to the cartel’s friends as well as members of the cartel itself. The Court emphasised that even “subsidiary, accessory or passive” participation was sufficient to incur some liability for the whole infringement. In that way, the judgment refines the understanding of the concept and scope of the cartel as a prohibited organisation.³⁸

Marine Hoses

The EC Decision in *Marine Hoses* describes the cartel as engaging a cartel coordinator, the name of whom is revealed elsewhere to be Peter Whittle of PW Consulting.³⁹ Surprise inspections were conducted at the premises of the cartel coordinator’s company and private home.⁴⁰ These inspections revealed that a series of written agreements among cartel members and other documents were maintained at the premises of the cartel coordinator’s company and that some incriminating documents were also stored at the cartel coordinator’s house.⁴¹

³⁵ *AC-Treuhand AG v Commission* [2008] ECR II-1501; [2008] 5 CMLR 13.

³⁶ Decision 80/1334 (n 25); Kallauger and Weitbrecht (n 30) 317.

³⁷ *AC-Treuhand AG v Commission* (T-99/04) [2008] 5 CMLR 13 at [130].

³⁸ Harding (n 15) 300–01.

³⁹ See, eg Sandra M Colino, *Competition Law of the EU and UK* (OUP 2011) 161.

⁴⁰ EC Decision in *Marine Hoses*, para 61.

⁴¹ *ibid* paras 74, 76, and 87.

In this cartel, part of the role of the cartel coordinator was to facilitate the rigging of bids:

Under the scheme, a member of the cartel who obtained a customer inquiry would report it to the cartel coordinator, who would in turn allocate the customer to a ‘champion’, which means the cartel member who was supposed to win the tender. In order to ensure that the tender was allocated to the ‘champion’ in the tendering procedure, the cartel members adopted a reference price list and agreed on the prices that each of them should quote so that all bids would be above the price quoted by the champion.⁴²

Harding provides further elaboration of the role of the coordinator in the *Marine Hoses* cartel:

The main role of Whittle’s company, PW Consulting Oil and Marine Ltd, was the implementation of the cartel agreement through the organisation of meetings, reports and sham contract bids, all of which were essential for the operation of the cartel. The substance of this “cartel co-ordination” is summed up in the following extract from the judgment: “This was a full-time job. The cartel was run as it had to be with meticulous attention to detail. Code names were used, clandestine meetings were organised and held, agreements were reached, both in relation to the market share and for the bogus contract bids. All of this was illustrated and monitored by monthly reports. There was a formally agreed decision-making process by which the successful company would be nominated as the champion for that contract. There were rules for compliance. The parties communicated through the use of code names when they or their companies became more concerned about compliance and they disguised their contract with one another and with [Whittle] through the use of email accounts that...had no connection with the companies they represented...All of the bid documentation had to be prepared...this was indeed a labour intensive exercise, time consuming and highly sophisticated.”⁴³

The cartel coordinator played a role in increasing and enabling the effectiveness of the cartel, thereby increasing the economic harm associated with it, and also played a role in the concealment of the cartel.⁴⁴ As stated by Harding, ‘Both of these elements of offending were some time ago captured in the well-know Sherman Act formulation of this kind of offending conduct, as a criminal offence under US law, as a conspiracy in restraint of trade or commerce.’

⁴² *ibid* para 71.

⁴³ *R v Whittle*, not yet reported, per Geoffrey Rivlin J. The judge addressed the defendant in passing a three year prison sentence, stating: ‘You were deeply involved in all this dishonesty; indeed it formed the basis of your whole working life.... You were the co-ordinator, and you did that job very efficiently.’

⁴⁴ Once more, what may be noted about this form of conduct is that it formed a substantial activity in its own right which was essential to the working of the cartel—that it contributed not only to the realisation of the cartel’s substantive objectives but also an important part of the cover-up operation. This point is stressed since it helps to convey an idea of what is delinquent and morally objectionable in cartel behaviour: that it is not only a matter of anticompetitive damage (what may be thought of as the substantive predicate offending) but also a matter of deliberate planning of something known to be illegal and with a strong element of sophisticated subterfuge. (Harding (n 15) p 302.)

Although the EC did not fine the cartel coordinator, Colino suggests that this may have been because of criminal proceedings against him in the UK.⁴⁵

IV. Summary of the model

We refer the reader to Appendix A for a formal statement of the model. In this section we provide a description of the key ingredients.

We consider a product manufactured by two firms that are engaged in collusion. Our results extend to a larger number of firms, but to illustrate the incentives of interest it is sufficient to consider only two firms.

The firms receive payoffs that depend on whether they are successfully prosecuted for collusion or not and whether they receive leniency. There are three levels of payoffs. The highest payoff occurs when no firm applies for leniency and the firms are not successfully prosecuted; the parameter π measures the collusive gain of a firm in such case. A firm receives the lowest payoff if the cartel is successfully prosecuted and it does not receive leniency; the firm loses the collusive gain and is fined a proportion f of such a gain. A larger value of the parameter f denotes a larger fine. A firm receives an intermediate payoff if the cartel is successfully prosecuted but it receives leniency; besides losing the collusive gain, the firm is fined a proportion ℓ of such a gain, with $\ell < f$. A lower value of the parameter ℓ signifies increased leniency, or greater fine reduction $f - \ell$.

The timeline of the model is as follows.

- (1) *Industry investigation*: The competition authority either begins an investigation or not. In the model, the investigation begins with a probability h that is influenced by the cartel's effort directed at concealing the existence of the cartel. If the competition authority does not begin an investigation, then the game ends and the firms receive the highest payoff. If the competition authority does begin an investigation, then the colluding firms initiate internal investigations.
- (2) *Internal investigations*: The internal investigations by the firms either uncover evidence sufficient to support a leniency application or not. Even though the firms were colluding, an internal investigation may not be able to uncover evidence sufficient to support a leniency application. This is especially true because the ability of a firm's outside antitrust counsel to uncover evidence of collusion depends on the cooperation of managers with knowledge of the conspiracy, whose interest may be to

⁴⁵ In 2009, PW Consulting escaped being fined after having organized meetings and generally helped to coordinate a cartel in the marine hose industry. The reason given by the Commission for this apparent inconsistency with its previous decisions [eg Organic Peroxides] was that it wished to avoid any risk of double jeopardy with the UK, where criminal proceedings against PW Consulting's former executive Peter Whittle were pending. ... It has been argued that a symbolic fine would have been more in line with established Commission policy towards cartel facilitators. (Colino (n 39) p 161.)

avoid detection,⁴⁶ and on whether the cartel has engaged consulting support to maintain incriminating documents offsite. In the model, the probability ρ that sufficient evidence is uncovered is influenced by the cartel's effort directed at limiting the success of such investigations. If a firm's internal investigation does not uncover evidence sufficient to support a leniency application then, obviously, that firm cannot apply for leniency. If a firm's internal investigation does uncover sufficient evidence, then the firm faces a choice about whether to apply for leniency or not. We assume that each firm must make its choice about whether to apply for leniency before learning whether the internal investigation at its co-conspirator uncovered evidence or not. In all cases, we assume that as a result of the internal investigation, each firm obtains information on the probability τ with which the competition authority will be able to successfully prosecute the cartel in the event that no firm applies for leniency.

- (3) *Leniency*: Firms that have uncovered evidence sufficient to support a leniency application simultaneously and independently make a choice about whether to apply for leniency or not. If both firms apply for leniency, then we assume that each firm has a 50-50 chance of being selected as the leniency recipient.
- (4) *Resolution*: If at least one firm applies for leniency, then we assume that the cartel is successfully prosecuted. If no firm applies for leniency, then we assume that there is randomness in whether the prosecution is successful or not. With probability τ prosecution is successful, and with the complementary probability it is not. The success of the prosecution together with whether a firm receives leniency or not determine its payoff.

V. Incentives in the model

Basic incentives

The model takes as given that firms are more likely to apply for leniency (in fact, in the model, will only apply for leniency) if the competition authority launches an investigation. In the absence of such an event, or some other triggering event, firms have much reduced concerns that the cartel will be successfully prosecuted

⁴⁶ By cooperating, a manager promotes the prosecution of the cartel, which would potentially leave the manager labelled as someone who has engaged in illegal price fixing, fired from his or her current position, and have severe future career consequences. Furthermore, if a manager cooperates, the firm may not get leniency, or if it does, that manager may be 'carved out' by the antitrust authority from the corporate leniency agreement and so face criminal prosecution. The DoJ may 'carve out' individuals from the protection of corporate leniency, including, historically, 'culpable employees, employees who refuse to cooperate with the Division's investigation, and employees against whom the Division is still developing evidence'. (Scott D Hammond, 'Charting New Waters in International Cartel Prosecutions' (2006) US Department of Justice, <http://www.usdoj.gov/atr/public/speeches/214_861.htm> accessed 15 July 2014). However, recently, the DoJ has indicated that it 'will no longer carve out employees for reasons unrelated to culpability', which presumably includes a refusal to cooperate. (Bill Baer, 'Changes to Antitrust Division's Carve-Out Practice Regarding Corporate Plea Agreements' (2013) US Department of Justice <<http://www.justice.gov/opa/pr/2013/April/13-at-422.html>> accessed 15 July 2014).

and also reduced concerns that their co-conspirator will preempt their ability to apply for leniency in the future. This is consistent with the value that competition authorities and economists have placed on allowing leniency applications after an investigation has already begun.

In the model, firms are more likely to apply for leniency if they are more likely to be successfully prosecuted in the event that there is no leniency applicant. More precisely, the model predicts that firms apply for leniency if the outside counsel uncovers evidence and the probability of being successfully prosecuted when no firm applies is above a threshold τ^* .⁴⁷ If a competition authority applies more resources to the prosecution of suspected cartels for which there is no leniency applicant, then this increases the incentive for firms to apply for leniency. Conversely, if a competition authority becomes less effective in prosecuting a cartel in the absence of a leniency applicant, then there is a reduction in the incentives for colluding firms to apply for leniency.

In the model, firms are more likely to apply for leniency if fines are higher (f is larger) or the benefits to firms from leniency are more valuable (ℓ is smaller).⁴⁸ Higher fines mean a lower payoff in the event that a firm is successfully prosecuted without leniency, which provides firms with a greater incentive to apply for leniency. In addition, the greater is the differential payoff to a firm from being caught and fined versus being caught and receiving leniency, the greater is the incentive to apply for leniency. Thus, increased benefits from leniency increase firms' incentives to apply for leniency.

Firms are more likely to apply for leniency if the internal investigation conducted by its co-conspirator is more likely to find evidence that is sufficient to support a leniency application (ρ is larger).⁴⁹ Economists have labelled this effect as the 'preemption effect' of leniency. It arises because a firm may seek leniency specifically because it expects its co-conspirator to apply for leniency—a firm may choose leniency because it is a means to pre-empt the leniency application of its co-conspirator.⁵⁰

Incentives for concealment effort

In what follows, we focus on how the incentives mentioned above affect a cartel's decision to engage in concealment effort. We begin with incentives related to the

⁴⁷ This follows from Proposition 1 in the Appendix A.

⁴⁸ This follows from Proposition 2 in the Appendix A, which shows that τ^* is decreasing in f and increasing in ℓ .

⁴⁹ This follows from Proposition 2 in the Appendix A, which shows that τ^* is decreasing in ρ .

⁵⁰ If the probability of prosecution in the absence of a leniency applicant is sufficiently large, then a firm will seek leniency even if it expects that the other firm will not. This is the 'prosecution effect'. Firms have an incentive to apply for leniency in order to avoid the penalties associated with being prosecuted. However, a firm may also seek leniency because it expects the other firm to apply for leniency. This is the pre-emption effect. A firm only prefers leniency as a means to pre-empt the leniency application of the other firm. See Harrington, 'Corporate Leniency Programs' (n 20) and Marx, Mezzetti and Marshall (n 7) on the prosecution and pre-emption effects created by leniency.

probability h of an initial investigation by the competition authority and then discuss incentives related to the probability ρ that an internal investigation will uncover evidence that can support a leniency application.

First, a leniency programme introduces two effects into the cartel's concealment effort directed at reducing (the probability of) investigations. The first effect is that with leniency a firm may reduce its loss when prosecuted by obtaining leniency. This effect pushes the cartel in the direction of reduced concealment. The second effect is that when the competition authority has evidence about illegal antitrust activity, the firm may apply for leniency and hence be successfully prosecuted with a higher probability than when there is no leniency programme. In our model, the second effect dominates and as a result the leniency programme increases the cartel's concealment effort directed at reducing investigations.⁵¹

Relative to the model without leniency, the competition authority is less likely initially to receive information about illegal antitrust activity, but once the competition authority does, the cartel is successfully prosecuted with higher probability because in some cases a cartel firm applies for leniency, providing the competition authority with the evidence required. Cartels optimally respond to the introduction of a leniency programme by increasing efforts directed at concealing the presence of the cartel, thereby mitigating the effects of the leniency programme in terms of detection. To the extent that an increase in this type of concealment effort reduces cartel profits, then the imposition of a leniency programme provides the benefit of making existing collusion less effective.

We mentioned in the introduction that one example of concealment effort aimed at reducing investigations is greater attention by a cartel to offering plausibly market-related justifications for their collusive price increases. Colluding firms might time collusive price increases to coincide with, for example, an exchange rate shock that, although unrelated to the collusive price increase, may be able to provide cover for the cartel. Price increases that buyers believe may be justified based on market fundamentals are less likely to face buyer resistance, which can be destabilizing to cartels. When an increase is plausibly justified, then although buyers may be displeased by the price increase, they can take comfort that an increase based on market fundamentals will affect all buyers and so they will not be disadvantaged relative to their competitors.⁵²

As another example of concealment effort aimed at reducing the probability of an investigation, a cartel could consider implementing some degree of customer switching, generating variability in market shares, or perhaps allowing a greater level of competition in some products.⁵³ To the extent that a competition

⁵¹ This follows from Proposition 3 in the Appendix B; with a leniency programme firms exert more concealment effort aimed at reducing the probability of an investigation h .

⁵² On cartel approaches to buyer resistance, see Vikram Kumar and others, 'Buyer Resistance for Cartel versus Merger' (2014) Working Paper, Duke University <<https://faculty.fuqua.duke.edu/~marx/bio/papers/cartelvmrger.pdf>> accessed 15 July 2014.

⁵³ A cartel in the parcel tanker industry suppressed rivalry on a number of dimensions, but not all dimensions: 'Importantly, the bid rigging was only for contracts of affreightment and only for existing customers. New

authority might rely on economic circumstantial evidence to inform its decision whether to launch an investigation, this type of behaviour could avoid the creation of certain plus factors to which the competition authority might be attentive.⁵⁴

When we relate effort targeted at avoiding investigations to the parameters of the model, we find that cartels engage in more concealment effort directed at lowering the probability of an investigation by the competition authority if the probability of successful enforcement is higher, the market is more profitable to the firms, or the fines are higher.⁵⁵ In addition, an increase in leniency benefits typically leads to an increase in effort directed at thwarting investigations by the competition authority.⁵⁶ This is because increased leniency benefits lead to an increase in leniency applications and hence prosecution after an investigation has started, thus providing an incentive for the firms to reduce the probability of investigation.

Second, we consider concealment effort directed at reducing the probability ρ that evidence is uncovered that would allow a leniency application. Because firms are more likely to apply for leniency if the internal investigation conducted by the other firm is more likely to uncover evidence,⁵⁷ the presence of a leniency programme provides incentives for firms to engage in concealment activities designed to thwart the ability of internal investigations to uncover evidence. Cartels optimally respond to the introduction of a leniency programme by increasing efforts directed at reducing the ability of inside counsel or outside antitrust counsel to uncover evidence sufficient to support a leniency application,⁵⁸ thereby mitigating the effects of the leniency programme in terms of detection.

Concealment effort of this type includes the revision of cartel firms' organizational charts to reduce the number of individuals within the firms that must be informed about the existence of the cartel. This may include the adjustment of sales force incentives so that the conduct of the sales force can be brought in line with cartel goals without informing the sales force of the existence of the cartel.⁵⁹ In addition, this type of concealment effort includes the use of third-party facilitators to maintain and conceal documents, facilitate meetings and exchanges of information in ways that avoid leaving traces in company accounts, and advise

customers' contracts were competitively bid. Similarly, regional trade, on routes not covered by the customer lists, was competitively bid.' (John Asker, 'Leniency and Post-Cartel Market Conduct: Preliminary Evidence from Parcel Tanker Shipping' (2010) 28 *Intl J Indus Org* 407–14, p 408.)

⁵⁴ See Richard A Posner, *Antitrust Law* (2nd edn, University of Chicago Press 2001) pp 79–93; and William E Kovacic and others, 'Plus Factors and Agreement in Antitrust Law' (2011) 110 *Michigan L Rev* 393–436.

⁵⁵ This follows from Proposition 4 in the Appendix B, which shows that optimal concealment effort directed at h is increasing in τ^E , the expected value of τ , π , and f .

⁵⁶ This follows from Proposition 4 in the Appendix B, which shows that optimal concealment effort directed at h is increasing in ℓ (decreasing in the value of the leniency benefits) as long as Equation (B.3) holds.

⁵⁷ This follows from Proposition 2 in the Appendix A.

⁵⁸ This follows from Proposition 5 in the Appendix B.

⁵⁹ See Marshall and Marx (n 24) ch 6.2.7 on cartels modifying within-firm incentives.

cartel members on how to avoid detection. The discussion in the Introduction and Section III provide multiple examples of this.

An increase in the probability that internal investigations uncover evidence means that a firm that has itself uncovered evidence sufficient to apply for leniency believes it is more likely that its co-conspirators will be in a similar position. This is especially true if its co-conspirators have maintained incriminating evidence in-house. If others are more likely to be in a position to apply for leniency, then a firm has a greater incentive to apply for leniency itself in an attempt to be the first in the door. This suggests that leniency programmes can be made more effective if the competition authority can take steps that enhance incentives for employees with knowledge of the conspiracy to cooperate and that facilitate the discovery of incriminating evidence. For example, a competition authority may be able to take steps that discourage cartels from outsourcing the running of the cartel or the control of incriminating evidence to third-party facilitators. One option would be to increase the penalties for firms that do so.

We can relate cartel effort devoted to reducing the probability of successful internal investigations to the parameters of the model. We find that typically cartels engage in more concealment effort directed at lowering the probability that an internal investigation uncovers sufficient evidence to support a leniency application if the market being cartelized is more profitable, fines for antitrust violation are higher, or leniency benefits are greater.⁶⁰ In addition, cartels engage in more concealment effort directed at lowering the probability of a successful internal investigation if antitrust enforcement in the absence of a leniency applicant is more effective in the sense that the probability of successful prosecution is higher.⁶¹

These results provide the warning that an increase in fines and/or leniency benefits associated with antitrust violations will likely lead to a number of different effects. It is not clear that the heavier are the sanctions, the more effective that leniency policies will be. Holding fixed the concealment effort of cartel firms, an increase in fines and/or leniency benefits increases leniency applications and detection of cartels. However, an increase in fines and/or leniency benefits also increases concealment effort, which reduces leniency applications and reduces the effectiveness of the leniency programme in the detection of cartels. Thus, for example, severe criminal sanctions and jail sentences for individuals may lead to a substantial increase in concealment. This concealment effort can potentially have consumer benefits if it leads colluding firms to behave in a way that reduces the effectiveness with which they elevate prices. However, it can

⁶⁰ This follows from Proposition 6 in the Appendix B, with the results related to the level of fines and level of leniency benefits holding for a distribution over the probability of successful prosecution in the absence of a leniency application that is sufficiently uniform over the range of possible values.

⁶¹ This follows from Proposition 6 in the Appendix B, where we model an increase in the probability of successful prosecution as an increase in the lower support of a uniform distribution for the probability of successful prosecution in the absence of a leniency applicant.

have a number of undesirable effects. In particular, it can provide incentives for cartels to be more professional in their approach to the ‘problem’ or organizing and implementing collusion, with long-run implications for the effectiveness of antitrust enforcement.

Competition authorities should be careful not to facilitate the concealment of cartel activities through, for example, prohibitions on leniency applications by cartel ringleaders or firms that have coerced others to join the cartel. If the competition authority limits the ability of a ringleader of the cartel or a cartel member that has coerced others to join, then the cartel can potentially pursue the strategy of maintaining all hard evidence related to the cartel at the headquarters of that firm. That would prevent internal investigations at firms other than the ringleader or coercer from being successful and so would prevent leniency applications by those firms. If the ringleader or coercer is prohibited from applying for leniency, then no firm is in a position to apply for leniency. Forbidding the ring leader or the coercer from applying for leniency would then eliminate the pre-emption motive for firms to apply for leniency and thus reduce the ability of authorities to detect collusion.⁶²

VI. Conclusion

The US antitrust leniency programme has been in place since 1993, and colluding firms have had an opportunity to adjust their behaviour to account for its presence. Our results point to the incentives that the introduction of a leniency programme provides for colluding firms to increase effort directed at concealing the cartel from authorities and at limiting the ability of an internal investigation by legal counsel to uncover evidence sufficient to support a leniency application. This potentially provides incentives for firms to outsource the running of the cartel, with negative consequences as far as professionalizing collusion, promoting additional collusive activity, and hampering enforcement.

A number of policy implications follow from the results of this article. Competition authorities should (i) use leniency programmes to enhance the detection of cartels; (ii) evaluate economic evidence of collusion in light of a cartel’s incentives to disguise its presence; (iii) take steps to improve the likelihood that internal investigations into possible antitrust offenses will be successful, including steps that enhance cooperation by employees, facilitate the discovery of incriminating evidence and impose increased penalties for cartels that use third-party facilitators.

⁶² On this and related points, see Donald C Klawiter, ‘Corporate Leniency: Maintaining the Integrity and Power of Antitrust Enforcement’s Most Effective Tool’ in Frank L Fine (ed), *China Institute of International Antitrust and Investment: First Annual Antitrust Symposium, 2013*, (LexisNexis 2013).

Leniency programmes have been recognized for their value in cartel detection.⁶³ This is supported by the economics literature, which shows that colluding firms will, in some settings, have an incentive to apply for leniency, thereby revealing the existence of a cartel and presumably ending the collusive conduct if it has not already ended. In the context of our model, a cartel comes under threat when a competition authority launches an investigation, and a colluding firm will apply for leniency if it perceives a sufficiently high threat that it will be successfully prosecuted if it does not apply. By applying for leniency, a firm avoids fines that would have been imposed if they were successfully prosecuted with no leniency applicant (the prosecution effect) and avoids fines that would have been imposed if their co-conspirator succeeded in applying for leniency (the pre-emption effect). It is through both the prosecution and pre-emption effects that a leniency programme improves cartel detection.

As we show in this article, the presence of a leniency programme increases incentives for colluding firms to invest in concealment to reduce the probability that they come under investigation and to reduce the ability of an internal investigation at one of the colluding firms to uncover evidence sufficient to support a leniency application. Given this, when a competition authority evaluates economic evidence, it must consider the possibility that a cartel has deliberately manipulated economic outcomes to conceal its presence. As an example, evidence of, say, customer switching, might ordinarily be viewed as evidence of competition. But customer switching can presumably be arranged by a cartel if it serves the purpose of disguise. Thus, a competition authority must be careful not to reject the possibility of collusion in a particular product simply because it observes economic evidence that, although normally associated more with competition than collusion, could have been generated by a cartel as camouflage.

Taking into account a cartel's incentive to prevent internal investigations from uncovering evidence of collusion, a competition authority may want to reduce the amount of evidence that is required to support a leniency application, as long as it ensures that having a leniency applicant provides a sufficient increase in the competition authority's ability to successfully prosecute a cartel. The effectiveness of the leniency programme would be enhanced if a competition authority had in its toolkit ways to facilitate the independent discovery of incriminating evidence or were able to give greater weight in assessing liability to things like the use of external email accounts, prepaid phones, etc. As a way to facilitate discovery competition authorities could take steps to encourage companies to adopt corporate whistleblowing policies that provide protection for whistleblowers against discrimination. If the competition authority can increase penalties for cartel members, other than the leniency applicant, that have engaged a third-party facilitator to support the collusive conduct and aid in

⁶³ See n 1.

concealment of the conspiracy, then this can also support the effectiveness of the leniency programme by reducing incentives for firms to engage such facilitators.

To conclude, the overarching lesson of this article is that competition authorities need to consider how clever cartels will respond to the leniency programmes put in place and take measures to counteract conspirators increased efforts at concealing their operations.

Appendix A

Formal statement of the model

The model is derived from the two-product model of Marx, Mezzetti, and Marshall and the text below is largely drawn from that article.

Firms are symmetric and π is each firm's payoff when it does not apply for leniency and is not prosecuted. A firm's payoff is $-f\pi$ when it is successfully prosecuted and fined (with no leniency granted), and $-\ell\pi$ when it is granted leniency. We let $\ell < f$, so that the leniency payoff is higher than when the firm is prosecuted without applying for leniency.⁶⁴

The timeline is as follows:

- (1) Both firms observe signal $s \in \{0, 1\}$, where $\Pr(s = 1) = h \in (0, 1)$. The realization $s = 1$ denotes that the competition authority has received evidence about illegal antitrust activity and has started an investigation, while $s = 0$ means that this has not happened.
- (2) Nothing happens if $s = 0$, but if $s = 1$, each firm brings in outside counsel to do an internal investigation. The internal investigation uncovers evidence sufficient to support a leniency application with probability $\rho \in (0, 1)$, in which case the outside counsel at firm i observes a conditionally independent random variable θ_i uniformly distributed in the interval $[\tau - \epsilon, \tau + \epsilon]$, where $\epsilon > 0$, centred on the realized value of the random variable τ , defined below. We will think of ϵ as 'small', so that τ is 'almost' perfectly observed by each firm and focus on the limit as $\epsilon \downarrow 0$.⁶⁵
- (3) Nothing happens if $s = 0$ or if $s = 1$ and the internal investigation did not uncover evidence sufficient to support a leniency application. But if $s_1 = 1$ and the internal investigation did uncover such evidence, then

⁶⁴ In the USA, firms receiving leniency may still be subject to penalties from civil litigation; however, exposure to those penalties is reduced for successful leniency applicants. 'Under the Antitrust Criminal Penalty Enhancement and Reform Act of 2004, Pub. L. No. 108-237, Title 2, §§ 211-214, 118 Stat. 661, 666-668, a leniency applicant may qualify for detrebling of damages if the applicant cooperates with plaintiffs in their civil actions while the applicant's former co-conspirators will remain liable for treble damages on a joint and several basis.' (Hammond and Barnett (n 2) p 18.)

⁶⁵ As described in Carlsson and van Damme, 'Global Games and Equilibrium Selection' (n 23), the global game result that iterated dominance forces each player to select the risk-dominant equilibrium of the game corresponding to his observation provided that ϵ is sufficiently small does not require the prior beliefs to be uniform, but holds for general priors.

the outside counsel at firm i advises the board of directors by reporting the observed value θ_i and the board decides whether to apply for leniency or not. If only one firm applies for leniency, it receives leniency. If both firms apply for leniency, one (and only one) is randomly designated as receiving leniency.

- (4) The competition authority concludes its investigation after observing an additional signal $v \in \{0, 1\}$ indicating the strength of the case; $v = 1$ signifies that the authority has enough evidence to successfully prosecute the firms, while $v = 0$ denotes insufficient evidence and the need to drop the case. We assume that $v = 1$ if there is at least one leniency applicant. If there is no leniency applicant, $\Pr(v = 1 | s = 0) = 0$ and $\Pr(v = 1 | s = 1) = \tau$. From the point of view of the firms, τ is a random variable with positive density $g(\tau)$ and distribution $G(\tau)$ with support on the interval $(0, 1)$; let $\tau^E = \int_0^1 \tau g(\tau) d\tau$ be the expected value of τ .

In the benchmark case without a leniency programme in place, the cartel is successfully prosecuted with probability $\Psi^N = h\tau^E$. A cartel firm's expected payoff is $V^N\pi$, where $V^N = (1 - \Psi^N) - \Psi^N f$.

If the firms come under investigation by the competition authority, then they must decide whether to apply for leniency after having conducted an internal investigation. If a firm does not uncover evidence, then it has no choice to make; it cannot apply for leniency. After uncovering evidence, a firm faces a strategic game. The firm (the row player) must decide whether to apply for leniency (L) or not (N) and its payoff depends on whether the other firm (the column player) applies for leniency in case it has uncovered evidence. The payoff of the row player is given by adding the baseline payoff $-f\pi$ to the entries in the table below.⁶⁶

	L	N	
L	$(1 - \frac{\rho}{2}) \pi (f - \ell)$	$\pi (f - \ell)$	(A.1)
N	$(1 - \rho) (1 - \theta_i) \pi (1 + f)$	$(1 - \theta_i) \pi (1 + f)$	

The perceived probability of successful prosecution in case of no leniency application is θ_i .

We can think of $-f\pi$, the firm's payoff when prosecuted and fined, as the baseline payoff of the row player. If the row player applies for leniency, then it receives leniency and a payoff of $\pi(f - \ell)$ above the baseline if the other firm does not apply after uncovering evidence (upper right cell). It receives leniency and a payoff of $\pi(f - \ell)$ above the baseline with probability $1 - \frac{\rho}{2}$ if the other firm does apply after uncovering evidence (upper left cell). This is because the only event in which the applying firm does not receive leniency is when the other firm

⁶⁶ The symmetry of firms does not play any role in the game; we could replace π with a different payoff π for each firm i without affecting the analysis.

uncovers evidence (which occurs with probability ρ), applies, and is selected to receive leniency by the random draw (which occurs with probability $\frac{1}{2}$).

When the row player does not apply for leniency, it is not prosecuted and receives a payoff of $\pi(1+f)$ above the baseline $-f\pi$ with probability $1-\theta_i$ if the other firm does not apply after uncovering evidence (lower-right cell) and with probability $(1-\rho)(1-\theta_i)$ if the other firm applies for leniency after uncovering evidence (lower-left cell).

As shown in Marx, Mezzetti, and Marshall, when θ_i is sufficiently large, applying for leniency is a strictly dominant strategy and (L, L) is the unique Nash equilibrium. As θ_i decreases, there is a range of values for θ_i such that there are two pure strategy Nash equilibria (L, L) and (N, N) , and equilibrium (L, L) is risk dominant.⁶⁷ As θ_i decreases further, there is a range of values for θ_i such that there continue to be two pure strategy Nash equilibria (L, L) and (N, N) , but (N, N) is risk dominant. Finally, for θ_i sufficiently small (and making the assumption that $\rho < \frac{2(1+\ell)}{2+f+\ell}$), no leniency is a dominant strategy and (N, N) is the unique Nash equilibrium.

Because we are interested in the case of a small error in the observation by firm i of the probability of successful prosecution, θ_i is approximately equal to τ . Define the cut-off value for the probability of prosecution below which (N, N) is risk dominant and above which (L, L) is risk-dominant in the basic leniency game by:

$$\tau^* \equiv 1 - \frac{(4-\rho)(f-\ell)}{2(2-\rho)(1+f)} > 0. \quad (\text{A.2})$$

We are now in a position to state Proposition 1 of Marx, Mezzetti, and Marshall, which exploits the fact that τ is a random variable that is imperfectly observed by the firms.

Proposition 1 (Marx, Mezzetti, and Marshall, Proposition 1) *If $\rho < \frac{2(1+\ell)}{2+f+\ell}$, then for ε sufficiently small, the subgame taking place after a signal $s=1$ has a unique Bayesian equilibrium that survives the iterated elimination of strictly dominated strategies. In such an equilibrium, when firm i uncovers evidence, it applies for leniency if it receives a signal $\theta_i > \tau^*$, and does not apply if it receives a signal $\theta_i < \tau^*$.*

As Proposition 1 shows, depending on the signals firms receive, firms for which leniency is feasible may choose to apply for leniency or may not. Henceforth, when computing payoffs and probabilities of successful prosecution, we take the limit as $\varepsilon \downarrow 0$, with the implication that the firms coordinate on either both applying for leniency when that is feasible or both not applying for leniency.

⁶⁷ Because the basic leniency game is symmetric, (L, L) is risk dominant if L is the best reply to the opponent's strategy of randomizing with equal probability between L and N .

Proposition 2 *With a leniency program, the thresholds τ^* and hence the region of signals in which the firms do not apply for leniency is increasing in ℓ and decreasing in f and ρ .*

Proof. It follows immediately from (A.2) that $\frac{\partial \tau^*}{\partial \ell} = \frac{(4-\rho)}{2(2-\rho)(1+f)} > 0$, $\frac{\partial \tau^*}{\partial f} = -\frac{(4-\rho)(1+\ell)}{2(2-\rho)(1+f)^2} < 0$, and $\frac{\partial \tau^*}{\partial \rho} = -\frac{(f-\ell)}{(1+f)(2-\rho)^2} < 0$. ■

The ex ante probability that the cartel will be successfully prosecuted when a leniency programme is in place is:

$$\Psi^L = h \left[1 - (1 - \rho)^2(1 - \tau^E) - \rho(2 - \rho) \int_0^{\tau^*} (1 - \tau)g(\tau)d\tau \right]. \tag{A.3}$$

To understand Equation (A.3), note that, conditional on the competition authority acquiring evidence, which occurs with probability h , the cartel is not successfully prosecuted if neither firm finds evidence to apply for leniency and then the competition authority is unable to succeed in the prosecution, which occurs with probability $(1 - \rho)^2(1 - \tau^E)$ —the second term in the square brackets—or if at least one firm finds evidence (probability $\rho(2 - \rho)$) but τ is less than τ^* and the authority is unable to successfully prosecute—the last term in the square brackets.

The expected payoff of a cartel firm is $V^L\pi$, where

$$V^L = 1 - \Psi^L(1 + f) + h\rho \left(1 - \frac{\rho}{2}\right)(f - \ell)(1 - G(\tau^*)). \tag{A.4}$$

A firm gets π with probability $1 - \Psi^L$ and a baseline payoff of $-f\pi$ with probability Ψ^L ; in addition, it gets $(f - \ell)\pi$ if it is the only firm to apply for leniency (probability $h[\rho(1 - \rho) + \frac{1}{2}\rho^2]\Pr(\tau > \tau^*)$), which generates the last term in Equation (A.4).

Appendix B

Formal statement of results on concealment effort

We extend the model and study the optimal choice of concealment effort by the firms. We assume that there is a preliminary stage in which the cartel chooses concealment effort directed at reducing the probability h with which the competition authority independently acquires evidence of collusion and separately concealment effort directed at reducing the probability ρ that an internal investigation by outside counsel uncovers evidence sufficient to support a leniency application. We compare the case in which there is no leniency policy with the case of leniency.

We assume $h \in [\underline{h}, \bar{h}]$ with $0 < \underline{h} < \bar{h} < 1$ and $\rho \in [\underline{\rho}, \bar{\rho}]$ with $0 < \underline{\rho} < \bar{\rho} < \frac{2(1+\ell)}{2+f+\ell}$. Let $C(h)$ be the per-firm cost of the effort needed to generate

probability h , where $C(\bar{h}) = 0$, $C' < 0$, and $C'' \geq 0$ and similarly for $\hat{C}(\rho)$, the per-firm cost of the effort needed to generate probability ρ .

Concealment effort directed at the probability of an investigation

Proposition 3 *Relative to the case of no leniency, a leniency program leads to an increase in the cartel's concealment effort directed at reducing the likelihood of an investigation by the competition authority.*

Proof of Proposition 3. Without a leniency programme, the cartel is successfully prosecuted with probability $\Psi^N = h\tau^E$. A cartel firm's expected payoff is

$$V^N\pi - C(h) = (1 - h\tau^E)\pi - h\tau^E f\pi - C(h).$$

Thus, the cartel chooses concealment effort so that the probability h^N that the competition authority receives information about illegal antitrust activity satisfies:

$$C'(h^N) = -\tau^E\pi(1 + f). \quad (\text{B.1})$$

With a leniency programme, the expected payoff of each firm is $V^L(h)\pi - C(h)$. The first order condition of the cartel's maximization problem gives:

$$\begin{aligned} C'(h^L)\frac{1}{\pi} &= \frac{\partial V^L(h^L)}{\partial h} \\ &= -\frac{\partial \Psi^L}{\partial h}(1 + f) + \rho\left(1 - \frac{\rho}{2}\right)(f - \ell)(1 - G(\tau^*)) \\ &= -\left[1 - (1 - \rho)^2(1 - \tau^E) - \rho(2 - \rho) \int_0^{\tau^*} (1 - \tau)g(\tau)d\tau\right](1 + f) \\ &\quad + \rho\left(1 - \frac{\rho}{2}\right)(f - \ell)(1 - G(\tau^*)) \\ &= -\tau^E(1 + f) - \rho(2 - \rho)(1 - G(\tau^*)) \left[(1 + f)E[1 - \tau | \tau > \tau^*] - \frac{1}{2}(f - \ell) \right]. \end{aligned} \quad (\text{B.2})$$

Because C is a decreasing, convex function, comparing the first order conditions for the choice of h with and without a leniency programme (ie comparing Equation (B.2) with Equation (B.1)), it is immediate that $h^N > h^L$ because the term in square brackets in the last line of Equation (B.2) is positive:

$$\begin{aligned} (1 + f)E[1 - \tau | \tau > \tau^*] - \frac{1}{2}(f - \ell) &\geq (1 + f)(1 - \tau^*) - \frac{1}{2}(f - \ell) \\ &= (f - \ell)\frac{2}{2(2 - \rho)} > 0. \quad \blacksquare \end{aligned}$$

Proposition 4 *In the absence of a leniency program, concealment effort directed at lowering the probability of an investigation by the competition authority is greater when (i) antitrust enforcement in the absence of a leniency applicant is more effective (higher τ^E), (ii) the market being cartelized is more profitable (higher π), or (iii) fines for antitrust violation are higher (higher f); in addition, if and only if (B.7) holds then with a leniency program concealment effort is greater when (iv) leniency benefits are greater (lower ℓ).*

Proof of Proposition 4. It is immediate from Equation (B.1) and the convexity of C that h^N is decreasing in τ^E , π , and f . Thus, colluding firms engage in more concealment effort directed at lowering the probability of an investigation by the competition authority if the probability of successful enforcement is higher, the market is more profitable to the firms, or the fines are higher.

We now show that h^L is increasing in ℓ , which means that concealment effort is decreasing in ℓ , if and only if $\frac{(1-\tau^*)g(\tau^*)}{1-G(\tau^*)} \geq (1 - \frac{\rho}{2})$. Take the derivative of the right side of Equation (B.2) (using the expression in the fourth line) with respect to ℓ and use the definition of τ^* to get

$$\begin{aligned} \frac{\partial}{\partial \ell} &= \rho(2 - \rho)(1 + f) \frac{\partial \tau^*}{\partial \ell} (1 - \tau^*)g(\tau^*) - \rho \frac{1}{2}(2 - \rho)(1 - G(\tau^*)) \\ &\quad - \rho \frac{1}{2}(2 - \rho)(f - \ell)g(\tau^*) \frac{\partial \tau^*}{\partial \ell} \\ &= \rho \left((1 - \tau^*)g(\tau^*) - \left(1 - \frac{\rho}{2}\right)(1 - G(\tau^*)) \right) \end{aligned}$$

which is positive if and only if

$$\frac{(1 - \tau^*)g(\tau^*)}{1 - G(\tau^*)} \geq \left(1 - \frac{\rho}{2}\right). \tag{B.3}$$

Thus, if Equation (B.3) holds an increase in leniency benefits leads to a decrease in effort directed at thwarting investigations by the competition authority, while lower leniency benefits lead firms to direct more resources at reducing the probability of an investigation. Note that if G is concave to the right of τ^* then Equation (B.3) holds. ■

Concealment effort directed at the probability of success of internal investigations

In the absence of a leniency programme, firms have no incentive to engage in concealment effort directed at reducing the success of internal investigations and so each sets $\rho^N = \bar{\rho}$. Clearly, the implementation of a leniency programme cannot reduce that type of concealment effort.

Proposition 5 *Concealment effort directed at reducing the success of internal investigations weakly increases (strictly if $-\hat{C}'(\bar{\rho}) < -\hat{V}'(\bar{\rho})$) with the introduction of a leniency program.*

When a leniency programme is in place, we can characterize how concealment effort is affected by changes in the parameters of the model.

Proposition 6 *With a leniency program, concealment effort directed at reducing the success of internal investigations is greater when (i) the market being cartelized is more profitable (higher π); (ii) fines for antitrust violation are higher (higher f) if $G \sim U[0, 1]$; (iii) leniency benefits are greater (lower ℓ) if $G \sim U[0, 1]$; or (iv) antitrust enforcement in the absence of a leniency applicant is more effective in the sense that $G \sim U[z, 1]$ and the lower bound z of the distribution increases.*

Proof of Proposition 6. Using Equation (A.3), one can show that

$$\frac{\partial \Psi^L}{\partial \rho} = h \left[(2 - 2\rho) \int_{\tau^*}^1 (1 - \tau)g(\tau)d\tau - \rho(2 - \rho)(1 - \tau^*)g(\tau^*) \frac{\partial \tau^*}{\partial \rho} \right].$$

With a leniency programme, the expected payoff of each firm is $V^L(\rho)\pi - \hat{C}(\rho)$. The first-order condition of the cartel's maximization problem is:

$$\begin{aligned} \hat{C}'(\rho^L) \frac{1}{\pi} &= \frac{\partial V^L(\rho)}{\partial \rho} \\ &= -\frac{\partial \Psi^L}{\partial \rho} (1 + f) + h(1 - \rho)(f - \ell)(1 - G(\tau^*)) \\ &\quad - h\rho \left(1 - \frac{\rho}{2}\right) (f - \ell)g(\tau^*) \frac{\partial \tau^*}{\partial \rho} \\ &= -2h(1 - \rho)(1 + f) \int_{\tau^*}^1 (1 - \tau)g(\tau)d\tau \\ &\quad + h(1 - \rho)(f - \ell)(1 - G(\tau^*)) \\ &\quad + h\rho(2 - \rho)(1 + f)(1 - \tau^*)g(\tau^*) \frac{\partial \tau^*}{\partial \rho} - h\rho \left(1 - \frac{\rho}{2}\right) (f - \ell)g(\tau^*) \frac{\partial \tau^*}{\partial \rho} \\ &= -h(1 - \rho) \left[2(1 + f) \int_{\tau^*}^1 (1 - \tau)g(\tau)d\tau - (f - \ell)(1 - G(\tau^*)) \right] \\ &\quad + h\rho(f - \ell)g(\tau^*) \frac{\partial \tau^*}{\partial \rho} \end{aligned} \tag{B.4}$$

Because \hat{C} is a decreasing, convex function, it is immediate that an increase in π must lead to a decrease in ρ^L and hence an increase in effort.

Note that if the derivative of the right side of Equation (B.4) with respect to parameter x is negative, then an increase in x results in a decrease in \hat{C}' , which means a decrease in ρ^L and a corresponding increase in concealment effort.

To see the effect of a change in f , differentiate the right side of Equation (B.4) with respect to f :

$$\begin{aligned} \frac{\partial}{\partial f} &= -h(1 - \rho) \left[2 \int_{\tau^*}^1 (1 - \tau)g(\tau)d\tau - 2(1 + f)(1 - \tau^*)g(\tau^*) \frac{\partial \tau^*}{\partial f} \right. \\ &\quad \left. + (f - \ell)g(\tau^*) \frac{\partial \tau^*}{\partial f} - (1 - G(\tau^*)) \right] + h\rho g(\tau^*) \frac{\partial \tau^*}{\partial \rho} \\ &\quad + h\rho(f - \ell)g'(\tau^*) \frac{\partial \tau^*}{\partial \rho} \frac{\partial \tau^*}{\partial f} + h\rho(f - \ell)g(\tau^*) \frac{\partial^2 \tau^*}{\partial \rho \partial f} \end{aligned}$$

which has an ambiguous sign. If G is the uniform distribution on $[0,1]$, then we have

$$\frac{\partial}{\partial f} = -h(1 - \rho)(1 - \tau^*)(2 + f + \ell) \left[\frac{(4 - \rho)}{2(2 - \rho)(1 + f)} - \frac{1}{1 + f} \right] + h\rho \frac{2 + f + \ell}{1 + f} \frac{\partial \tau^*}{\partial \rho} < 0,$$

where we use $\frac{\partial \tau^*}{\partial f} = -\frac{(4-\rho)(1+\ell)}{2(2-\rho)(1+f)^2} = -(1 - \tau^*) \frac{(1+\ell)}{(f-\ell)(1+f)}$ and $\frac{\partial^2 \tau^*}{\partial \rho \partial f} = -\frac{(1+f)-(f-\ell)}{(1+f)^2(2-\rho)^2} = \frac{\partial \tau^*}{\partial \rho} \frac{1}{(f-\ell)} - \frac{\partial \tau^*}{\partial \rho} \frac{1}{(1+f)}$ (see the proof of Proposition 2) and the definition of τ^* . Thus, for $G \sim U[0, 1]$, an increase in f leads to a reduction in ρ^L and hence corresponds to an increase in concealment effort.

To see the effect of a change in ℓ , differentiate the right side of Equation (B.4) with respect to ℓ :

$$\begin{aligned} \frac{\partial}{\partial \ell} &= -h(1 - \rho) \left[-2(1 + f)(1 - \tau^*)g(\tau^*) \frac{\partial \tau^*}{\partial \ell} + (1 - G(\tau^*)) + (f - \ell)g(\tau^*) \frac{\partial \tau^*}{\partial \ell} \right] \\ &\quad - h\rho g(\tau^*) \frac{\partial \tau^*}{\partial \rho} + h\rho(f - \ell)g'(\tau^*) \frac{\partial \tau^*}{\partial \rho} \frac{\partial \tau^*}{\partial \ell} + h\rho(f - \ell)g(\tau^*) \frac{\partial^2 \tau^*}{\partial \rho \partial \ell} \\ &= h(1 - \rho) \left[[2(1 + f)(1 - \tau^*) - (f - \ell)]g(\tau^*) \frac{\partial \tau^*}{\partial \ell} - (1 - G(\tau^*)) \right] \\ &\quad - h\rho g(\tau^*) \frac{\partial \tau^*}{\partial \rho} + h\rho(f - \ell)g'(\tau^*) \frac{\partial \tau^*}{\partial \rho} \frac{\partial \tau^*}{\partial \ell} + h\rho(f - \ell)g(\tau^*) \frac{\partial^2 \tau^*}{\partial \rho \partial \ell}, \end{aligned}$$

which has an ambiguous sign. If G is the uniform distribution on $[0,1]$, then we have

$$\frac{\partial}{\partial \ell} = 2h(1 - \rho)(1 - \tau^*) \frac{\rho}{2(2 - \rho)} + \frac{2h\rho(f - \ell)}{(1 + f)(2 - \rho)^2} > 0.$$

Thus, for $G \sim U[0, 1]$, a decrease in ℓ , ie an increase in the leniency benefits, leads to a reduction in ρ^L and hence an increase in concealment effort.

Suppose that $G \sim U[z, 1]$, where $z < \tau^*$. Then we can consider the effect of an increase in z , the lower bound of the distribution on τ . We can write Equation (B.4) as

$$\hat{C}'(\rho^L) \frac{1}{\pi} (1 - z) = -h(1 - \rho) \left[2(1 + f) \int_{\tau^*}^1 (1 - \tau) d\tau - (f - \ell)(1 - \tau^*) \right] + h\rho(f - \ell) \frac{\partial \tau^*}{\partial \rho}.$$

Using this expression and the assumption that \hat{C}' is negative, an increase in z requires a decrease in $\hat{C}'(\rho^L)$, and so a decrease in ρ^L and an increase in concealment effort. ■