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Endogenous Cartel Organization and Antitrust Fine Discrimination

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Third parties such as trade associations often assist cartels by collecting and evaluating market behaviour at the firm level. Under incomplete information neutral market oversight helps to distinguish defecting from complying behaviour, increasing the effectiveness of punishments for defectors and increasing cartel persistence. We investigate how cartels sort themselves into different organizational forms and whether cartel enforcement can be improved by setting fines contingent on the organizational form. A fine reduction for firms operating without the help of a third party causes some cartels to switch to a less persistent organizational form. Two drawbacks of this fine differentiation are that some new cartels will arise and that some of the existing cartels will become more persistent as the need to punish defectors decreases. Our paper is the first in the marginal deterrence literature to identify this second effect.

JEL classifications: K21, K42, L41

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1 Introduction

1.1 Motivation and main results

The stability and the persistence of a cartel depend on the ability of its participants to punish firms that deviate from the cartel agreement. For effective punishment, defective behaviour must be recognized as such. However, in a world with incomplete information, this might not always be possible. For example, individual demand fluctuations could be attributed either to fluctuations in aggregate demand or to defective behaviour on the part of other cartel members.¹ Motta (2004) names limited transparency in the form of the observability of prices as a major factor impeding cartel stability. Cartels respond to this obstacle by means of various organizational forms. One commonly observed mechanism to alleviate the problem resulting from incomplete information is the engagement of third parties that monitor individual behaviour and report deviations from the cartel agreement to the other members. This allows punishment to be more effective and furthermore ensures neutrality of the monitor relative to an organization with a ringleader. Extensive empirical evidence documents this mechanism as a common form of cartel organization: Genesove and Mullin (2001) report anecdotal evidence on how a trade association collects and disseminates information about the market behaviour of all colluding firms. If a firm defects from the agreement or does not comply with its reporting duties, the trade association will recommend punitive measures to the other cartel members. Kühn (2001) argues that the motivation behind the historic origin of trade associations was exactly this collusion-facilitating role. Levenstein and Suslow (2011) report that 31% of cartels in a recent international sample of convicted cartels operated with the help of trade associations. Their result confirms similar magnitudes found in earlier studies.

The common involvement of trade associations (henceforth TA) or other third parties² in cartels raises some interesting research questions that to date have not been considered in the literature on collusive practices. In this paper, we first explain how a cartel chooses its organizational form, with or without third-party assistance, based on the level of uncertainty and on the level of antitrust enforcement. We then derive optimal enforcement policies, taking into account the fact that cartel organization is an endoge-

¹See Green and Porter (1984).

²Clark (1983) cites auditing firms as monitors of relevant data such as sales quantities. Based on a sample of cartels recently convicted by the European Commission, Marshall and Marx (2008) report that other third-party monitors often include technical standard committees and "consulting firms". As trade associations seem to be the most prominent type of third party, we refer to them exclusively throughout this article.

nous variable and that different organizational forms lead to different probabilities of cartel breakdown, even when firms adhere to collusive strategies (e.g., because the cartel is prosecuted and desisted or because a firm is mistakenly punished by the other colluders). We refer to a cartel with a low probability of such death as persistent. In this model, we propose that the legislator might be able to increase welfare by decreasing the fine for cartels that operate without the help of third parties relative to the fine for cartels with third-party assistance.

Our argument for improving antitrust enforcement by fine differentiation proceeds as follows: The fine reduction for cartels operating without TA involvement induces some cartels to select this organizational form, even though organizing with the help of a TA would imply a more persistent cartel. The firms are willing to accept lower persistence of the cartel in order to obtain a lower expected fine, as the firms' objectives are to maximize their expected values from cartelization, which are influenced by both the per period profits and the persistence of the cartel (that is the expected profits in future periods). The objective of the antitrust authority (henceforth AA), given that some cartels cannot be deterred, is to minimize cartel persistence. The enforcement benefit from fine differentiation results here from the fact that the objectives of the two parties are not diametrically opposed to each other.

However, two drawbacks arise from fine differentiation. First, as the deterrence threshold decreases, some new cartels will form that would not have been stable under a uniformly high fine. Secondly, the cartels that organize without the help of a TA also become more persistent. As their expected fine decreases, the value of collusion increases and the strength of the endogenous threat of punishment for deviation, which guarantees incentive compatibility, can be reduced. An optimal rate of fine reduction will balance the marginal rates of these effects.³

We note finally that this fine differentiation corresponds to the legal standard in Europe. Council Regulation (EC) No 1/2003 explicitly states that trade associations involved in a cartel are also subject to antitrust fines. In general, the legislation allows the AA to fine each participating firm up to 10% of the firms' total turnover in the preceding business year. It further states, that if an association is involved, the total fine amount, that is the sum of all fines applied to firms and eventually to the TA, can not exceed 10% of the total revenues of the infringing firms. If trade associations are supposed to be fined and if aggregated fines achieve this upper legal bound (which is optimal, according to

³Note that similar to our mechanism, other enforcement mechanisms such as leniency programmes, can also improve enforcement efficacy, although some new cartels will be created as a result of their introduction, see e.g. Motta and Polo (2003).

Becker (1968)), then the individual fines for firms must be lowered relative to the legal maximum. For example, the legal maximum could correspond to the aggregate fines, composed of the total fines for firms and the residual fine for the TA. Individual firms would then have the option to refrain from organizing with the assistance of a TA and would thus benefit from fines that are lower than the legal maximum by the residual fine. To the best of our knowledge, we are the first to provide an economic justification for this feature of European competition law.

1.2 Related literature

Methodically, our model applies the concept of marginal deterrence from the general law and economics literature (see for instance Shavell (1992) for a seminal contribution) to the case of cartel organization. Briefly summarized, this literature finds that when individuals can choose between exclusive crimes, fines for actions with relatively limited welfare harm should be lowered relative to fines for crimes inflicting large welfare harm, such that individuals will choose the former instead of the latter. As there is in our model endogenous heterogeneity in cartel stability, we find that marginal deterrence is an applicable concept even when the per-period welfare harm of the different crimes is a priori identical. In our model, marginal deterrence is applicable because the criminal act will be repeated in the future with different probabilities, and these probabilities are affected by the fine differentiation. Additionally, we establish the existence of a novel effect in the framework of marginal deterrence. The fine reduction for the crime resulting in less welfare harm causes the frequency of this crime to increase, even for the set of criminals who would commit this crime already under homogeneous fines, because the probability of cooperation after the observation of a possible deviation can be increased without threatening incentive compatibility. Our analysis could thus be applied to all sorts of collective crimes that are repeatedly executed.

Thematically, our paper is connected to two branches of literature. First, it is related to research of trade associations and other third parties or direct communication between firms as collusion facilitators and secondly, it is related to the antitrust enforcement literature. Regarding the latter research field, it is broadly connected with the general antitrust enforcement literature such as Motta and Polo (2003) and Besanko and Spulber (1989) by a shared objective to deter and desist antitrust violations in particular cartels. More specifically, our work is related to certain papers within this domain that employ a marginal deterrence approach to antitrust violations. One such study is provided by Houba et al. (2011), who determine the optimal structure between cartel harm and fines, when firms endogenously set prices. Fines that increase over-proportionally in welfare

harm might be optimal. Under such a system a cartel inflicting low levels of welfare harm (that is, a small price overcharge) would become more attractive relative to both a more serious cartel (large price overcharge) and to legal behaviour (the competitive benchmark). Our paper features a similar idea. The main distinction is, that firms react in the two models differently to the fine differentiation. In the model constructed by Houba et al. (2011) firms can choose between different levels of welfare harm by setting different prices, while in our model, cartel harm varies according to the persistence of the cartel, which can be affected by the firms by choosing the level of organizational depth. Cosnita-Langlais and Tropeano (2013) indirectly employ a marginal deterrence approach. Here, the authors consider merger and cartel formation to be substitutable strategies that entail different welfare effects because the merger may result in efficiency gains which cannot be realized with a cartel. They conclude that merger policy should not be too strict if cartel enforcement is either too costly or too erroneous.

Furthermore, within the antitrust enforcement field, our paper is related to models in which cartel organization is endogenous and is impacted by antitrust enforcement institutions. For example, Bartolini and Zazzaro (2011) analyse how the formation of a cartel and the number of firms within the cartel is affected by fines and conclude that fines might increase the welfare harm of cartels. Chen (2008) and Dargaud and Jacques (2010) analyse collusion and the optimality of leniency programmes when the cartelizing firms can delegate the decision right whether to collude within their firms. So far, to our knowledge no paper with a law and economics approach to collusion has considered the possibility of firms to overcome obstacles of cartel stability by the means of third-party communication.

In the literature on collusion facilitators, the role of trade associations is well documented, both anecdotally (Kühn, 2001; Genesove and Mullin, 2001) and quantitatively (Levenstein and Suslow, 2006, 2011). The theoretical literature has focused on direct communication between firms,⁴ with the notable exception of Aoyagi (2005) who analyses communication with a third-party mediator. He provides a folk theorem specifying when communication with a mediator allows collusion. We are not aware of any studies in which cartel communication takes enforcement institutions into account.

The rest of the paper is structured as follows. In Section 2, the repeated game and its timing, strategies and payoffs are introduced. Section 3 determines whether firms are able to cartelize and what organizational form they select. Section 4 shows how fine

⁴Important contributions in this literature include Athey and Bagwell (2001), Athey et al. (2004), Harrington and Skrzypacz (2007) and Harrington and Skrzypacz (2011). For the case of non-collusive static oligopoly settings, information sharing has already been analysed by Gal-Or (1985) and Jin (1994).

differentiation between the two different organizational forms affects this choice and the incentive-compatibility constraints. Furthermore, conditions for the optimality of a fine differentiation are determined. Section 5 discusses possible extensions of our model and derives policy implications.

2 The model

Our model extends a simplified version of the Green and Porter (1984) collusion model as presented by Tirole (1988). In an infinitely repeated game an unspecified number of symmetric firms decide in each period whether to collude or to compete with one another. Under a collusive agreement, firms must then decide whether to comply with this agreement or to deviate. The profits of the different strategies depend on the realization of aggregate market demand, which is drawn in each period from a binary random distribution. With probability α , demand will be zero and the profits resulting from all strategies will likewise be zero. With counterprobability $(1 - \alpha)$ demand will be positive and the profits of the participating firms will be given by the standard reduced-form assumptions below, which can be easily derived from e.g. a standard Bertrand oligopoly model. Under collusion each firm will receive profits of π^C , however, is tempted to deviate from the cartel agreement and will then realize deviation profits $\pi^D > \pi^C$. Under the competitive market outcome, we normalize profits to be zero. Firms only observe their own individual demands and profits, but not total market demand or profits of the other firms. If a firm observes that its individual demand is zero after it has chosen the collusive action, two conclusions would be logically valid. Either total demand is zero or at least one firm has deviated from the cartel agreement and has received (eventually jointly with others) the entire demand e.g. by marginally lowering the price in the Bertrand example. As both individual actions and profits received are private information the firms cannot distinguish these two cases. Therefore, it is possible that the cartel members will erroneously retaliate after observing zero demand (e.g. under a grim trigger strategy) or mistakenly continue to collude (only possible in a strategy profile more lenient than grim triggers).

Our extension to this standard Green and Porter (1984) model is twofold. First, we introduce exogenous antitrust enforcement parameters (to which the AA is able to commit). Namely, we assume that the AA will discover a stable cartel with exogenous probability β and will convict it with certainty, meaning that each firm will have to pay a fine F_i where the subscript i indicates that the fine can be different for different types of cartels, as will be explained later. We assume that after conviction the cartel

has to shut down forever. Although in the real world some recidivism seems to exist, it has been shown that prosecution has a strong desistance effect and consequently is this assumption widely used in the literature.⁵ Furthermore, we assume that the cartel can be detected and desisted in future periods independent of the demand realization, but that the fine is only applied when demand is positive. If demand would be zero the cartel would not be inflicting any welfare harm and thus, it cannot be punished (e.g. due to legalistic reasons). Detection in our model should be possible independent of the demand realization, as firms form a collusive agreement and decide whether to adhere to it before the demand is realized. Similarly, we assume that the cartel is not prosecuted when a firm deviates, which could for instance be justified by the observation that deviating firms might simultaneously apply for leniency (although we do not model this explicitly). Also, it is in the interest of the AA to increase the attractiveness of a deviation. The common discount factor is given by $\delta \in [0, 1]$.

As described in the introduction, firms often assign a third party to collect data on the behaviour of cartel members and to instruct them in how to behave in order to ensure cartel stability. As a second extension to Green and Porter (1984), in our model, the firms can at the beginning of the game (that is in a period zero before the first stage game commences)⁶ choose whether to collude with or without the help of a trade association. The former cartel organization requires firms to disclose their individual profits to the trade associations. We assume that the TA perfectly recognizes the true profits and can thus deduct the firms' past actions.⁷ The work of Genesove and Mullin (2001) has demonstrated that cartel agreements grant TAs wide-ranging rights of inspection,⁸ e.g. accounting data as well as production facilities, such that the assumption that the TA cannot be deceived is reasonable.⁹ Formally, we assume that the entire set of individual profits becomes known to all cartel insiders by the means of the TA's involvement.¹⁰ As

⁵See e.g. Choi and Gerlach (2012) for a discussion.

⁶Alternatively it could be assumed with the same result that the firms choose the cartel organization at the beginning of each stage game, as in every period this choice would not be affected by the history of earlier stage games and would thus remain identical over all periods.

⁷From a modelling perspective, Marshall et al. (2011) is related to our work. They assume, as we do, that within a Green-Porter framework some cartels can distinguish deviations from aggregate demand fluctuations while others cannot. The only difference is that they assume this ability to be exogenously determined by a random distribution while we assume it to be an endogenous choice of the colluding firms.

⁸See also Stocking and Watkins (1991) for a discussion of the inspection rights of trade associations.

⁹Athey and Bagwell (2001) and Athey et al. (2004) assume similarly perfect monitoring in a (in this case, direct) communication scenario.

¹⁰We do not explicitly model the behaviour of the TA. Note that this eliminates the possibility of any type of principal-agent problem. Potential approaches of endogenizing the TA's behaviour and their implications are discussed in the conclusion.

it is an empirical fact that in practice not all cartels operate with the help of the TA, this organizational form must also have some disadvantages. As Levenstein and Suslow (2011) have shown the propensity to be prosecuted increases significantly when a TA is involved. This seems intuitive, as the involvement of a TA leaves a longer "paper trail" and as there will be more witnesses and potential informants who can instigate an investigation by the AA. Thus, we assume that the probability of prosecution is $q\beta$, with $q > 1$ for collusion with the help of third parties. As described, the level of the fine can be contingent on the organizational form that is, F_N for stand-alone cartels and F_T for cartels operating with the help of a TA.

The following figure illustrates the timing of the stage games. Remember here that the decision of whether to employ a TA or not is taken in a period 0 before the first stage game.

Figure 1: The timing of the stage game

Regarding firm strategies, we assume that a cartel that organizes with a TA follows a grim trigger strategy. That is, firms punish every deviation from the cartel agreement with a reversion to competitive behaviour forever. For a cartel without TA assistance, this assumption is too strict because once market demand is found to be zero, the punishment of eternal competitive equilibrium would be triggered. As long as the incentive-compatibility constraint of collusion is guaranteed, the value of collusion can be increased by more lenient punishment. In the standard collusion model with deterministic demand it is payoff-irrelevant whether firms employ grim triggers or a less severe but incentive-compatible punishment strategy. Under stochastic demand, Green and Porter (1984) assume that after observing zero individual demand, firms will punish for an exogenous number of T periods before returning to collusion. The objective of their model is to show that temporary price wars are compatible with stable cartel agreements, and that these wars can also be triggered by demand shocks. As we are not interested in the duration of punishment, we instead assume that firms will revert to the competitive equilibrium forever with endogenous probability $1 - \gamma^*$, and with counterprobability γ^* they will onwards comply with the collusive agreement. For the analysis of cartel stability, this is quantitatively equivalent to the extension of the Green and Porter (1984) model by Ti-

role (1988), who endogenizes T when $\gamma = \delta^T$, and simplifies the analytical solution of the game. Consider the case in which the cartel is formed without the help of the TA. The value of collusion is then given by $V_N^C = (1 - \alpha)(\pi^C - \beta F_N) + (1 - \beta)((1 - \alpha) + \alpha\gamma)\delta V_N^C$, which is equivalent to

$$V_N^C = \frac{(1 - \alpha)(\pi^C - \beta F_N)}{1 - (1 - \beta)(1 - \alpha + \alpha\gamma)\delta}, \quad (1)$$

while the value of an unilateral deviation is given by $V_N^D = (1 - \alpha)\pi^D + (1 - \beta)\delta\gamma V_N^C$, that is

$$V_N^D = (1 - \alpha)\pi^D + (1 - \beta)\delta\gamma \frac{(1 - \alpha)(\pi^C - \beta F_N)}{1 - (1 - \beta)(1 - \alpha + \alpha\gamma)\delta}, \quad (2)$$

where the subscript N indicates that these are the values when no trade association is involved. Under collusion involving a TA, there is no reason to set the punishment probability at less than one, since an undeserved punishment is not possible in that case. The value of collusion is independent of the punishment probability, and thus the cartel is indifferent between any probabilities as long as the incentive constraint is fulfilled. It is therefore not a restrictive assumption that firms in this setting will apply grim trigger strategies. The value of collusion is then given by

$$V_T^C = \frac{(1 - \alpha)(\pi^C - q\beta F_T)}{1 - (1 - q\beta)\delta}. \quad (3)$$

Defecting from the facilitated cartel agreement yields a deviation value determined by the expected one-shot deviation profits

$$V_T^D = (1 - \alpha)\pi^D, \quad (4)$$

where we assume that the TA also can determine in the zero demand case whether a firm has deviated. This seems reasonable in our model, as firms must make their pricing decisions before observing demand (see Figure 1), and the TA can monitor these decisions.

In the next section we determine the conditions under which the firms cartelize with or without a TA or fail to cartelize at all.

3 The decision on (the kind of) collusion

Three critical threshold values are required to be identified to determine firm behaviour. The incentive-compatibility constraints of the two types of cartels determine whether collusion is stable, and a comparison between the expected payoffs for the two types of collusion determines the optimal choice of organization. We are interested in the question, how these thresholds change with variations in β and α as the detection probability and the demand volatility are the key parameters driving firm strategies with respect to cartel organization. Later, we will consider a set of industries distributed in some (α, β) space. The following section will show that when the fine is lower for N-type collusion (without the involvement of a TA), the thresholds will change such that there will be less T-cartels (in which TAs are involved) but more cartels total. We first examine the incentive-compatibility condition of the N-cartel. This form of cartel is stable whenever $V_N^C \geq V_N^D$, that is,

$$\alpha \leq \frac{(1 - \beta)\delta(\pi^D - \gamma(\pi^C - \beta F_N)) - (\pi^D - (\pi^C - \beta F_N))}{(1 - \gamma)(1 - \beta)\delta\pi^D}. \quad (5)$$

Remember that $\gamma \in [0, 1]$ is endogenously chosen by the firms. The value of collusion increases in γ , but it must be small enough to satisfy the incentive constraint above. As $\pi^D > \pi^C - \beta F_N$ the denominator of equation (5) decreases in γ faster than the numerator. Thus, the incentive-constraint is more easily fulfilled when γ is small. It can be fulfilled for some $\gamma > 0$ whenever equation (5) holds for $\gamma = 0$, that is,

$$\alpha \leq \frac{\pi^C - \beta F_N - (1 - (1 - \beta)\delta)\pi^D}{(1 - \beta)\delta\pi^D} \equiv \tilde{\alpha}_N, \quad (6)$$

This is a sufficient condition, but when it is slack, the cartel can afford to punish without threatening cartel stability with a probability of less than one. With the optimal punishment probability $1 - \gamma^*$ which fulfils the incentive-compatibility constraint with equality (and is always smaller than one), determined by

$$\gamma^* = \frac{\pi^C - \beta F_N - (1 - (1 - \beta)(1 - \alpha)\delta)\pi^D}{\delta(1 - \beta)(\pi^C - \beta F_N - \alpha\pi^D)}, \quad (7)$$

(where the denominator is larger than zero when if the right-hand side of equation 5 is positive), the value of collusion becomes

$$V_N^{C*} = \frac{\pi^C - \beta F_N - \alpha\pi^D}{1 - (1 - \beta)\delta}. \quad (8)$$

Note that $\tilde{\alpha}_N$ is decreasing in β . This is intuitive, since when the probability of prosecution increases the incentive constraint becomes harder to fulfil, because the payoff of the collusive strategy decreases. This must be balanced by a decrease in demand volatility to ensure stability. In addition, the value of collusion decreases in both α and β , and collusion of the N-type is profitable for any positive value of $\tilde{\alpha}_N$.

The incentive-compatibility constraint for T-type cartels is given by

$$V_T^C \geq V_T^D \Leftrightarrow \beta \leq \frac{\pi^C - (1 - \delta)\pi^D}{q(\delta\pi^D + F_T)} \equiv \tilde{\beta}_T. \quad (9)$$

This critical value does not react to variations in the demand volatility, as all payoffs are only realized for positive demand. Thus, the probability $(1 - \alpha)$ cancels out of the constraint. Intuitively, the TA, which is by assumption perfectly able to distinguish demand shocks from defective behaviour, neutralizes any effect of volatility on the value of collusion. It also holds, that whenever collusion is stable under the T-organization, it would also be stable for the N-organization if α is small enough, that is, $\tilde{\alpha}_N > 0$ for all $\beta \leq \tilde{\beta}_T$.

Finally, we consider the condition which of the two types is more profitable determining the firms' choice of organizational form, which is taken before the decision whether to deviate.

$$V_N^{C*} \geq V_T^C \Leftrightarrow \alpha \leq \frac{(1 - (1 - \beta q)\delta)(\pi^C - \beta F_N) - (1 - (1 - \beta)\delta)(\pi^C - \beta q F_T)}{(1 - (1 - \beta q)\delta)\pi^D - (1 - (1 - \beta)\delta)(\pi^C - \beta q F_T)} \equiv \tilde{\alpha}_S. \quad (10)$$

When α is large enough, firms prefer to cartelize without a TA, because this neutralizes the adverse effect of demand volatility on cartel stability. Without the TA the cartel breaks down with some positive probability after zero demand is realized. The critical value of the sorting condition is increasing in β . When the probability of conviction is high, the cartel prefers an organizational form without external help, because otherwise the probability of conviction would increase by a factor $q > 1$ which is more severe when β is large. If the probability of a demand shock increases, the cartel will be willing to accept a higher probability of conviction, since the service of the trade association will be more valuable. An example of the critical values in a (β, α) space is depicted in the following Figure 2. The result is summarized in Lemma 1.

Lemma 1. *The cartel forms and is incentive-compatible*

- i. without the help of a trade association if $\alpha \leq \min[\tilde{\alpha}_N, \tilde{\alpha}_S]$,*

ii. with the help of a trade association if $\beta \leq \tilde{\beta}_T$ and $\alpha > \tilde{\alpha}_S$,

iii. not at all if $\beta > \tilde{\beta}_T$ and $\alpha > \tilde{\alpha}_N$.

Proof. Follows from (6), (9) and (10). □

Figure 2: The sorting condition and incentive-compatibility constraints

From this, it is easy to show that under equivalent fines $F_N = F_T$, whenever the cartel forms with the help of a TA, then this is the more persistent and thus more welfare-harming cartel organization, where cartel breakdown is determined by (i) the probability of conviction ($q\beta$ under T-collusion, β under N-collusion) and (ii) the probability of punishment (zero under T-collusion, $(1-\gamma)$ under N-collusion). In contrast, the expected profit from the current period from the cartel is determined only by the probability of conviction and is therefore strictly larger under N-collusion. Thus, if the cartel organizes with the help of a TA, this must entail an increase in the persistence of the cartel which outweighs the higher expected fine. Let $\bar{W}$ be the per period welfare harm of a stable cartel under either form of organization.¹¹ Then, the expected ex-ante welfare harm is given by $W_N = (1-\alpha)\bar{W} + ((1-\alpha)(1-\beta) + \alpha\gamma^*)\delta W_N$, that is,

$$W_N = \frac{(\pi^C - \beta F_N - \alpha \pi^D)\bar{W}}{(1 - (1-\beta)\delta)(\pi^C - \beta F_N)}, \quad (11)$$

¹¹We assume that, given stability, the two organizational forms cause the same level of welfare harm, e.g. because they are able to sustain the same level of collusive prices. See the conclusion for a discussion how to generalize this.

for the cartel without the trade association, taking the endogenous punishing probability $(1 - \gamma^*)$ into account, and by

$$W_T = \frac{(1 - \alpha)\overline{W}}{1 - (1 - q\beta)\delta}, \quad (12)$$

for the cartel with trade association assistance. The following Propositions then holds.

Proposition 1. *Given equivalent fines ($F_N = F_T$), whenever a cartel organizes with the help of a trade association ($\alpha > \tilde{\alpha}_S$) it causes more welfare harm than it would cause without the help of the trade association ($W_T > W_N$).*

Proof. See Appendix. □

This creates room for potential welfare increases by fine differentiation, since for $F_N < F_T$ some cartels will switch to the less persistent N-type organizational form relative to the policy setting with equivalent fines. The fact that (given constant firm behaviour), fines are welfare-neutral but affect firms' payoffs implies that the objective of the AA is not diametrically opposed to the objectives of the firms. Thus, a different setting of enforcement institutions can affect the optimization problem of the firms such that they will choose an organizational form that is less welfare harming.

Furthermore, note that the inversion of Proposition 1 does not hold. If the cartel organizes without a TA, it must not necessarily be more stable in this way, because it benefits from the lower fine. Thus, an opposite fine differentiation ($F_T < F_N$) is at the margin necessarily welfare harming (though the third welfare effect would not occur, since N-type cartels do not need to adjust the punishment probability).

4 Fine differentiation

We now consider the case in which the firms of the cartel receive a discount $\kappa \in [0, 1]$ on their fines when a TA is not involved, that is, the fines are given by $F_T = F$ and $F_N = (1 - \kappa)F$.¹² From a technical perspective, an asymmetric increase in fines would yield the same effects, however, the two drawbacks would be reversed to become benefits. First, the general deterrence threshold would increase (rather than decrease) for certain cartels, just as identified by Becker (1968). Secondly, the threat of punishment would have to

¹²We assume that the AA always correctly recognizes whether a TA is involved in the cartel. Although this is not a completely accurate depiction of real-world characteristics, it is not a restrictive assumption. If a T-cartel, which were to be fined, receives with a certain probability falsely also the reduced fine, the reduction in fine would result in a lower impact on the choice of organizational form. Additional insights do not follow from this extension.

be increased (rather than decreased, as in the setting with an asymmetric fine decrease), since the value of collusion would decrease. The beneficial effect of switching to a less persistent organizational form of the cartel would remain unchanged. An asymmetric fine increase might thus be preferable to an undifferentiated fine increase. Although this form of fine differentiation is unambiguously positive, we follow the approach of an asymmetric fine decrease in our exposition. It is commonly accepted that enforcement is improved by a fine increase. The fact that fines are limited in practice must thus result from other reasons which are not examined in this model.¹³

The modification of the incentive constraint for cartels not employing a trade association as well as that of the sorting condition induced by the fine reduction are straightforward. These conditions are now represented by

$$V_N^C \geq V_N^D \Leftrightarrow \alpha \leq \frac{\pi^C - \beta F(1 - \kappa) - (1 - (1 - \beta)\delta)\pi^D}{(1 - \beta)\delta\pi^D} \equiv \tilde{\alpha}_N(\kappa), \quad (13)$$

for the incentive-compatibility constraint and the sorting conditions is given by $V_N^C \geq V_T^C$, which is equivalent to

$$\alpha \leq \frac{(\pi^C - \beta F(1 - \kappa))(1 - (1 - \beta q)\delta) - (\pi^C - \beta q F)(1 - (1 - \beta)\delta)}{(1 - (1 - \beta q)\delta)\pi^D - (1 - (1 - \beta)\delta)(\pi^C - \beta q F)} \equiv \tilde{\alpha}_S(\kappa). \quad (14)$$

It clearly holds that

$$\frac{\partial \tilde{\alpha}_N}{\partial \kappa} = \frac{\beta F}{(1 - \beta)\delta F} > 0, \quad (15)$$

that is, some cartels that were previously unstable are now stable, which is what we would expect from a decrease in fines. In addition,

$$\frac{\partial \tilde{\alpha}_S}{\partial \kappa} = \frac{(1 - (1 - q\beta)\delta)\beta F}{(1 - (1 - q\beta)\delta)\pi^D - (1 - (1 - \beta)\delta)(\pi^C - q\beta F)} > 0, \quad (16)$$

that is, some cartels switch from an organizational form with the assistance of a TA to the form without a TA. The first effect is clearly welfare harming, as new cartels will become stable. The second effect has unambiguously positive welfare consequences as a corollary of Proposition 1, since all cartels that switch to an organization without a TA

¹³Typically cited examples are, e.g. avoidance activities (Malik, 1990) and judicial error (Polinsky and Shavell, 1989). Sidak and Block (1980) discuss why fines should be limited in the antitrust context. For a general survey on the public enforcement of law, see Polinsky and Shavell (2007) and for a survey on antitrust law enforcement, see Kaplow and Shapiro (2007). Of course, the fine is also limited by the firms' abilities to pay the fine, see Craycraft et al. (1997) for an analysis in the antitrust context.

are thereby less persistent. It is straightforward to show that the two cross-derivatives $\partial^2 \tilde{\alpha}_N / \partial \kappa \partial \alpha$ and $\partial^2 \tilde{\alpha}_S / \partial \kappa \partial \alpha$ are positive. This means that as α is increasing, more new cartels will arise and more cartels will switch to N-type collusion for a given level of fine differentiation.¹⁴ There is also a third welfare effect of the fine differentiation, arising from the fact that the endogenous punishment probability in the N-cartel can be lowered by the fine reduction, because collusion becomes more profitable. The value of collusion increases with the reduction of the fine. Defecting is thus less of a threat and the punishment probability can be lowered without threatening cartel stability. Mathematically speaking, the probability of cooperation after observing zero demand increases,

$$\frac{\partial \gamma^*}{\partial \kappa} = \frac{\beta(1-\alpha)(1-(1-\beta)\delta)F\pi^D}{\delta(1-\beta)(\pi^C - \beta F(1-\kappa) - \alpha\pi^D)^2} > 0, \quad (17)$$

which ultimately leads to an increase in welfare harm as given by

$$\frac{\partial W_N}{\partial \kappa} = \frac{\beta\alpha F\pi^D \bar{W}}{(1-(1-\beta)\delta)(\pi^C - \beta F(1-\kappa))^2} > 0. \quad (18)$$

The persistence of these cartels increases. The following figure depicts the first two effects of a fine reduction. Proposition 2 concludes.

Proposition 2. *Relative to the fine schedule $F_N = F_T$, the fine schedule $F_N < F_T$*

- i. weakens the incentive compatibility constraint for N-cartels, i.e. $\frac{\partial \tilde{\alpha}_N}{\partial \kappa} > 0$,*
- ii. biases the sorting condition in favour of N-cartels, i.e. $\frac{\partial \tilde{\alpha}_S}{\partial \kappa} > 0$, and*
- iii. increases the welfare harm of N-cartels, i.e. $\frac{\partial W_N}{\partial \kappa} > 0$.*

Proof. Follows from (15), (16) and (18). □

¹⁴The cross-derivative of the sorting condition reduces to
$$\frac{(1-(1-\beta q)\delta)(1-\delta)(\pi^D - \pi^C) + q\beta\delta((1-(1-\beta q)\delta)(\pi^D - q\beta F) - (1-(1-\beta)\delta)(\pi^C - q\beta F))}{((1-(1-q\beta)\delta)\pi^D - (1-(1-\beta)\delta)(\pi^C - q\beta F))^2} > 0.$$

Figure 3: The effect of fine differentiation

Finally, we derive sufficient conditions for some amount of fine differentiation to be optimal because it is a priori unclear whether the positive second effect dominates the two others. Assume that β is drawn for each industry from a binary distribution $[\beta_L, \beta_H]$, with $\beta_H > \tilde{\beta}_T \geq \beta_L$ such that a fraction θ of industries will be convicted with probability β_L and a fraction $1 - \theta$ with probability β_H .¹⁵ Furthermore, for each industry, the realization of β remains identical over all periods and is public knowledge. Finally, assume that α is distributed in $[0, 1]$ according to the density function $f(\alpha)$ independent of the realization of β . Then, industries with low conviction probability will collude without trade associations for $\alpha \in [0, \tilde{\alpha}_S(\kappa)]$ and with the help of trade associations for $\alpha \in [\tilde{\alpha}_S(\kappa), 1]$, while industries with high investigation probability will collude without the help of trade associations for $\alpha \in [0, \tilde{\alpha}_N(\kappa)]$ and never otherwise. Given that $W_N(\alpha, \kappa)$ and $W_T(\alpha)$ denote the welfare harm inflicted by a cartel with the respective organizational form as defined above, the total welfare loss from cartelization over all industries is given by

$$W(\theta, \kappa) = \theta \left(\int_0^{\tilde{\alpha}_S(\kappa)} W_N(\alpha, \kappa) f(\alpha) d\alpha + \int_{\tilde{\alpha}_S(\kappa)}^1 W_T(\alpha) f(\alpha) d\alpha \right) + (1 - \theta) \int_0^{\tilde{\alpha}_N(\kappa)} W_N(\alpha, \kappa) f(\alpha) d\alpha, \quad (19)$$

which should in our policy setting be minimized by optimizing over the parameter

¹⁵See e.g. Bryant and Eckard (1991), who shows that the probability of detection is different for different cartels and how this probability is affected by characteristics such as industry effects and geographical scope.

κ . The first-order condition is in accordance with the ordering of effects listed in the proposition above, given by

$$(1 - \theta) \frac{\partial \tilde{\alpha}_N}{\partial \kappa} f(\tilde{\alpha}_N) W_N(\tilde{\alpha}_N) + \theta \frac{\partial \tilde{\alpha}_S}{\partial \kappa} f(\tilde{\alpha}_S) (W_N(\tilde{\alpha}_S) - W_T(\tilde{\alpha}_S)) \\ + \theta \int_0^{\tilde{\alpha}_S(\kappa)} \frac{\partial W_N(\alpha)}{\partial \kappa} f(\alpha) d\alpha + (1 - \theta) \int_0^{\tilde{\alpha}_N(\kappa)} \frac{\partial W_N(\alpha)}{\partial \kappa} f(\alpha) d\alpha = 0. \quad (20)$$

The first term describes the effect by which some new cartels become stable through the lowered fine on N-cartels. The second term represents the fact that some cartels are now willing to select a less persistent organizational form, which has been shown to be positive (that is negative in terms of welfare losses, as in the above expression) by Proposition 1. The third and fourth terms together express the effect whereby stable N-cartels have a lower probability of breakdown because they can lower the punishment probability.

Example: Uniform distribution. For simplicity, we consider a situation in which α is uniformly distributed in the interval $[0, 1]$. The optimal κ^* is determined by equation (25) in the Appendix. The following proposition then holds.

Proposition 3. *For $\alpha \sim u[0, 1]$, if $q < \bar{q}$ there exists a $\bar{\theta}$ such that $\kappa^* > 0$ for $\theta > \bar{\theta}$.*

Proof. See Appendix. □

Note that the only negative effect on the social loss (that is, a positive welfare effect) arises in the population of cartels with a low conviction rate. Thus, the marginal rate of this effect can outweigh the sum of the marginal rates of the two other effects only if the fraction of industries with low conviction rates is high enough. Even then, this is only possible if within this population the marginal effect at $\kappa = 0$ outweighs the marginal effect of stabilizing the existing N-cartels that is found in the same set of cartels. The reason that fine differentiation is only optimal when q is small enough is twofold. First, when q decreases, more cartels form with the help of a TA and hence is the negative effect that the N-type cartels can lower their punishment probability weakened. Secondly, the sorting condition $\tilde{\alpha}_S(\kappa)$ is more strongly affected by changes in κ when q is small (that is, $\partial^2 \tilde{\alpha}_S / \partial \kappa \partial q < 0$).

Figure 4 depicts an example of Proposition 3 in which total expected welfare loss is a function of κ and θ . The parameter configuration is chosen as follows: $\pi^C = 5$, $\pi^D = 6$, $q = 1.1$, $F = 10$, $\delta = 0.95$. The values for the probability of conviction must fulfil

$\beta_L \leq \bar{\beta}_T < \beta_H$. With above numerical values, we determine these probabilities by setting $\beta_L = \bar{\beta}_T$ and β_H is determined by $\tilde{\alpha}_N|_{\kappa=0} = 0$. This implies that for equivalent fines no collusion would exist in industries with a high probability of collusion. However, when the fine is lowered, some cartels colluding without a TA will arise. The numerical values are given by $\beta_L \approx 0.272$ and $\beta_H \approx 0.299$. By this approach, the cartel is profitable, even though the fine is much larger than the collusive profit. For the depiction, $\bar{W}$ is chosen to be one, however, this only affects the height on the plane not any slope, because it affects all marginal effects with respect to β and κ equally. As can be seen from the figure welfare harm is strictly increasing in the level of fine reduction when θ is small enough. However, as θ increases lowering the fine becomes more attractive and eventually reaches an optimum $0 < \kappa^* < 1$ when θ is high enough. In our example, welfare harm has an interior minimum for variations of κ for values of θ larger than about 0.85. Note, however, that welfare harm is increasing in θ as the proportion of industries with low probabilities of conviction increases. Thus, fine differentiation is only optimal when the cartel enforcement efficacy is sufficiently weak. Similarly, the parameter q , which must be sufficiently small, can be interpreted as an inverse measure of enforcement effectiveness. When q is low, it is unlikely that the AA will react strongly to evidence. It seems that fine differentiation is only a second-best, when antitrust enforcement is sufficiently weak, for instance, if the enforcement budget is low.

Figure 4: Total welfare loss

5 Conclusion

There are multiple ways in which cartels organize themselves to overcome obstacles to stability. Different strategies offer varying advantages that can help to minimize the risk of internal or external cartel breakdown. One of the methods of increasing internal cartel persistence is to engage a third party, commonly a trade association, to oversee the behaviour of the colluding firms and to determine optimal punishment strategies. However, this may come at the cost of higher probability of external cartel death. Our analysis has shown that it can be reasonable for the antitrust authority or legislator to set fine levels contingent on the organizational form of the cartel. Although this may result in the creation of some new cartels, other cartels will be willing to switch to a less persistent organizational form.¹⁶ In addition to providing an economic rationale for this feature already existent in the legal framework of antitrust enforcement, the paper extends our knowledge about the optimality of marginal deterrence. We show that in a framework in which criminal acts are carried out repeatedly by teams and where deviations from these acts are profitable (that is a repeated prisoners' dilemma), (i) that it can be optimal to differentiate fines even when the per-period harm caused by different crimes is identical, because fine differentiation affects the probabilities that the crime will be repeated in future periods and (ii) that an additional effect exists, which influences the optimal fine differentiation because a fine reduction affects the organization's need to punish deviators.

This paper can be extended in several directions. First, the behaviour of the trade association can be endogenized or made more explicit. A goal of enforcement policies could then be to stir up principal-agent problems between the cartel and the TA. A potential source for such tensions would be a leniency programmes, in which the third party is also eligible for fine reductions. As TAs do generally not have a sizeable budget and are largely funded by the participating firms (i.e., the firms in the cartel), this might be an especially interesting prospect, when individual liability and leniency are also considered. Principal-agent problems could further arise due to the asymmetric interests of the firms in the TA. Secondly, a more complex choice of organizational form could be considered, which might strengthen the impact of fine differentiation. This could also take the form that different ways of cartel organization are able to sustain different sets of cartels prices. Marginal deterrence could be then applied to sets of crimes that vary in their severity along two dimensions, the degree of organizational depth and

¹⁶The finding that optimal cartel enforcement only achieves underdeterrence is a common result, e.g. Besanko and Spulber (1989).

the price overcharge. Another interesting aspect arises when firms are asymmetric, such that no price is a natural focal point for collusive equilibrium selection. As an additional service to the colluding firms, the TA could then assist in the coordination of a collusive price. Because this would also incur larger social costs of collusion our analysis would be strengthened. Finally, policy parameters other than the fine could be adjusted to alter the organizational design and thereby the stability of the cartel. For example, investigation priorities could be set higher for cartels that are known to operate using organizational forms with high internal stability. In addition, the communication and exchange of data between firms and trade associations could be regulated.

Appendix

Proof of Proposition 1

Evaluating the expected welfare harm at $\alpha = \tilde{\alpha}_S$, that is when firms are indifferent between different cartel organizations results in

$$W_N(\tilde{\alpha}_S) = \frac{(\pi^C - q\beta F_N)(\pi^D - (\pi^C - \beta F_N))\bar{W}}{(\pi^C - \beta F_N)((1 - (1 - q\beta)\delta)\pi^D - (1 - (1 - \beta)\delta))(\pi^C - q\beta F_T)}, \quad (21)$$

under cartel organization without a trade association and

$$W_T(\tilde{\alpha}_S) = \frac{(\pi^D - (\pi^C - \beta F_T))\bar{W}}{(1 - (1 - q\beta)\delta)\pi^D - (1 - (1 - \beta)\delta)(\pi^C - q\beta F)} \quad (22)$$

for assisted cartels. Under equivalent fines $F_N = F_T = F$ the difference between welfare losses is given by

$$W_N(\tilde{\alpha}_S) - W_T(\tilde{\alpha}_S) = \frac{-\beta(q - 1)F\pi^D\bar{W}}{(\pi^C - \beta F)((1 - (1 - q\beta)\delta)\pi^D - (1 - (1 - \beta)\delta))(\pi^C - q\beta F)}, \quad (23)$$

which is always negative. Thus the welfare harm at the point of indifference between organizational forms is always larger for organizations employing trade associations. Furthermore, it can be shown that the difference

$$W_N(\alpha) - W_T(\alpha) = \frac{\left(\beta\delta(q-1)\overline{W} - \alpha((1-(1-q\beta)\delta)\pi^D - (1-(1-\beta)\delta)(\pi^C - q\beta F))\right)\overline{W}}{(1-(1-q\beta)\delta)(1-(1-\beta)\delta)(\pi^C - \beta F)} \quad (24)$$

is strictly decreasing in α . Thus, the welfare loss for all $\alpha \geq \tilde{\alpha}_S$ is larger for a cartel with a trade association. As this describes all cases in which a trade association is employed, this concludes the proof of Propositions 1.

Proof of Proposition 3

Proof. Under the specified uniform distribution of α , the first-order condition for the κ minimizing the social loss from cartels becomes

$$\begin{aligned} 0 = & (1-\theta) \frac{\beta_H F}{(1-(1-\beta_H)\delta)\pi^D} \frac{(\pi^D - (\pi^C - \beta_H F(1-\kappa)))\overline{W}}{\pi^C - \beta_H F(1-\kappa)} \\ & - \theta \frac{(1-(1-q\beta_L)\delta)\beta_L F}{((1-(1-q\beta_L)\delta)\pi^D - (1-(1-\beta_L)\delta)(\pi^C - q\beta_L F))^2} \frac{(q-(1-\kappa))\beta_L F\pi^D\overline{W}}{(\pi^C - \beta_L F(1-\kappa))} \\ & + \theta \frac{1}{2} \frac{\beta_L F\pi^D\overline{W}}{(1-(1-\beta_L)\delta)(\pi^C - \beta_L F(1-\kappa))^2} \frac{((q-1)\beta_L(\delta\pi^C + (1-\delta)F) + (1-(1-q\beta_L)\delta)\kappa\beta_L F)^3}{((1-(1-q\beta_L)\delta)\pi^D - (1-(1-\beta_L)\delta)(\pi^C - q\beta_L F))^3} \\ & + (1-\theta) \frac{1}{2} \frac{\beta_H F\pi^D\overline{W}}{(1-(1-\beta_H)\delta)(\pi^C - \beta_H F(1-\kappa))} \frac{((\pi^C - \beta_H F(1-\kappa)) - (1-(1-\beta_H)\delta)\pi^D)^3}{((1-\beta_H)\delta\pi^D)^3} \end{aligned} \quad (25)$$

where the first two lines correspond to the first two effects from Proposition 2, and the last two lines to the third effect. Note, that the second effect is negative, thus decreasing the welfare loss. A minimal condition is that the sum of the second effect and the first part of the third effect is negative. Evaluating this sum at $\kappa = 0$ delivers a negative value when

$$\begin{aligned} & 2(1-(1-q\beta_L)\delta)(1-(1-\beta_L)\delta)(\pi^C - \beta_L F) > \\ & \frac{(q-1)^2\beta_L^2(\delta\pi^C + (1-\delta)F)^3}{((1-(1-q\beta_L)\delta)\pi^D - (1-(1-\beta_L)\delta)(\pi^C - q\beta_L F))} \end{aligned} \quad (26)$$

Clearly, the right-hand side approaches zero when q approaches one, while the left-hand side stays positive. Thus, this condition is fulfilled when q is small enough. Furthermore, if this holds these two effects dominate the first effect and the second part of

the third effect when θ is sufficiently large. This concludes the proof. $\square$

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