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Opportunistic competition law enforcement [a]

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Abstract in English

Most studies of competition law enforcement treat competition authorities as all-knowing, unwavering and benevolent. They do not behave opportunistically, do not face asymmetric information and choose their actions to optimize social welfare.
In this paper, we drop one of these assumptions, and study a competition authority that can not commit to a particular investigation strategy. As a consequence, a competition authority's decisions to investigate will be driven by the (ex-post) desistance effect instead of the (ex ante) deterrence effect of an investigation policy. The resulting opportunistic behaviour may lead to a suboptimal investigation strategy.
To analyse the interplay between investigation policies, deterrence and desistance, we study a model in which a competition authority monitors multiple sectors and faces a budget constraint that prevents it from deterring cartels in all sectors simultaneously. We find that, in the absence of commitment, developing a sector specific reward scheme based on the number of captured cartels can improve welfare.

Key words: cartels, competition law, commitment

JEL code: L13, L41, L44

Abstract in Dutch

De theoretische literatuur over het handhaven van de mededingingswet gaat er meestal vanuit dat een mededingingsautoriteit alwetend, standvastig en welwillend is. Ze handelt niet opportunistisch, kent geen informatieasymmetrie, en kiest haar acties om de maatschappelijke welvaart te maximaliseren.
Dit paper laat één van deze aannames los en bestudeert een mededingingsautoriteit die zich niet kan commiteren aan een bepaalde onderzoeksstrategie. Als gevolg hiervan laat de mededingingsautoriteit zich bij haar onderzoeksbeslissingen leiden door het (ex post) oppakeffect in plaats van het (ex ante) afschrikeffect van een onderzoeksstrategie. Dit opportunistische gedrag kan leiden tot een suboptimale onderzoeksstrategie.
We bestuderen het samenspel tussen de onderzoeksstrategie, het afschrikken en het pakken van kartels voor een mededingingsautoriteit die de mededingingswet met een beperkt budget in meerdere sectoren tegelijk moet handhaven. We vinden dat opportunistisch gedrag leidt tot een suboptimale allocatie van mensen en middelen. Een sectorspecifiek beloningssysteem voor de mededingingsautoriteit gebaseerd op het aantal gepakte kartels kan de allocatie verbeteren.

Steekwoorden: kartels, mededingingsbeleid, commitment

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Summary

Competition authorities play an important role in the regulation of markets. They enforce competition law by detecting and sanctioning anticompetitive behaviour like collusion or abuse of dominance.

Most studies of competition law enforcement treat competition authorities as all-knowing, unwavering and benevolent. They do not behave opportunistically, do not face asymmetric information and choose their actions to optimize social welfare.

In this paper, we drop one of these assumptions, and study a competition authority that can not commit to a particular investigation strategy. As a consequence, a competition authority's decisions to investigate will be driven by the (ex-post) desistance effect instead of the (ex ante) deterrence effect of an investigation policy.

Deterrence arises when cartels do not form because the detection probability is too high. Desistance results when cartels are stable, in spite of a vigilant competition authority, but are subsequently caught after which they revert to competitive behaviour for some time. The incentive for a competition authority to behave opportunistically arises because once an investigative strategy has deterred enough cartels, the competition authority will want to focus on desistance instead.

To analyse the interplay between investigation policies, deterrence and desistance, we study a model in which a competition authority monitors multiple sectors and faces a budget constraint that prevents it from deterring cartels in all sectors simultaneously. The absence of commitment will then result in a suboptimal allocation of resources. We find that, in the absence of commitment, developing a sector specific reward scheme based on the number of captured cartels can improve welfare.

1 Introduction

Competition authorities play an important role in the regulation of markets. They enforce competition law by detecting and sanctioning anticompetitive behaviour like collusion or abuse of dominance. The goal of competition law is inherently economic: making sure the market process works effectively. This has led economists to study how policies that aim to contribute to achieving this goal should be designed. Competition authorities are gradually discovering how to use such studies in designing their enforcement policies. Theoretical and empirical analysis has for example aided policymakers in the design of leniency policies by competition authorities (Spagnolo (2000), Motta and Polo (2003) , Harrington (2005), Aubert et al. (2006) and Chen and Rey (2007), and in the development of fining guidelines (Connor and Bolotova (2006)).

In most studies of the interaction between a competition authority and firms, the former is treated as unwavering, all-knowing and benevolent. It does not behave opportunistically, does not face asymmetric information, and chooses its actions to optimize total welfare. This contrasts with the economic theory of the interaction between regulators and firms. Here, the possibility of opportunistic behaviour by regulators and asymmetric information are seen as essential features of the regulatory environment, which determine what regulatory policies are feasible (Laffont (1994); Armstrong and Sappington (2007)).

Some issues arising from information asymmetry have been studied in the context of competition law. For example, Besanko and Spulber (1989) study optimal competition policies when cartels' production costs are private information. Schinkel and Tuinstra (2006) address the implications of imperfect competition law enforcement on the strategic behaviour of firms. These studies generally conclude that it is socially optimal to tolerate some level of collusion, in line with the well-known trade-off between efficiency and rent extraction resulting from information asymmetry.

However, the consequences of the absence of commitment have not been studied in the context of competition law yet. In general, the possibility of opportunistic behaviour will reduce the effectiveness of regulator policies. For example, investments levels may be lower, in essence because firms expect to be expropriated once investments are sunk (Besanko and Spulber (1992); Laffont and Tirole (1992)). Designing policies that allow regulators to commit can therefore improve welfare. In financial markets, for example, economists argue for the independence of central banks, because this allows them to focus credibly on keeping inflation low (Barro (1983); Barro (1986); and Vickers (1986)).

The central strategic variable that a competition authority can use to influence firms' behaviour, is its investigation strategy. By investigating a sector more or less intensively, for example by allocating more or less resources to it or auditing it with a higher frequency, the probability with which cartels are detected in this sector decreases or increases. In the literature on optimal competition law enforcement, a competition policy is therefore generally defined as

the probability of detection chosen by the competition authority. An essential assumption in most, if not all, of this literature is that a competition authority does not behave opportunistically, and that it can stick to an announced audit strategy even if the strategy is not optimal ex post.

The crucial importance of this assumption was already noted by Besanko and Spulber (1989), who state 'In the absence of a credible commitment to sue (...) the deterrence effects of antitrust policy would be lost'. The consequences of the absence of commitment and potential remedies have been investigated in the context of income tax audit policy (Graetz and Wilde (1986), Melumad and Mookherjee (1989)) and fraud detection strategies for insurance firms (Picard (1996)). However, little progress has been made in incorporating these ideas into a theory of optimal competition law enforcement.

We think it is not realistic to assume that a regulator can credibly commit itself to an investigation policy. As noted by Spulber (1989), commitments are hard to verify because it is hard to observe how much effort the competition authority devotes to the detection and prosecution of cartels. It may be easy to hide internal reallocations of resources from the outside world and there is no outside agency with the coercive power to enforce the actual implementation of a particular policy. Consequently, it is difficult for the competition authority to restrict its future actions, especially when those actions may increase social welfare ex post. Since the consequences of opportunistic behaviour by the competition authority for competition law enforcement may be large, we conclude that the issue warrants further investigation.

In this paper, we aim to take a small step in treating competition authorities more realistically by assuming that a competition authority can behave opportunistically. To study the resulting commitment problem, we analyse the interplay between detection probabilities, deterrence and desistance. Deterrence arises when cartels do not form because the detection probability is too high. Desistance results when cartels are stable, in spite of a vigilant competition authority, but are subsequently caught after which they revert to competitive behaviour for some time. The incentive for a competition authority to behave opportunistically arises because once an investigative strategy has deterred enough cartels, the competition authority will want to focus on desistance instead.

In reality competition authorities probably value desistance to some extent. This can be inferred from the way in which some competition authorities (for example the Dutch Competition Authority, NMA, and British Competition Authority, OFT) try to measure the effect on welfare of their enforcement activities. They estimate the deadweight loss caused by the cartels caught (assuming that these stop colluding at least for a while), but ignore the deterrence effect.[1] If taken literally, this implies a pure focus on ex post effects of enforcement. More realistically, it suggests that competition authorities put at least some value on desistance.

[1] They mention that deterrence may also exist, but ignore it because it can not be measured. This can be justified if fines or detection probabilities are too low, for then the deterrence effects equals zero.

It is also clear that competition authorities value deterrence. Indeed, competition authorities sometimes publicly pre-announce their enquiries into certain sectors and publish the results. For example, the European Commission (EC) announced the start of sector enquiries in the electricity & gas sector and the financial markets in 2005, whereas the Dutch and British competition authorities (OFT) annually present their investigative priorities. The reasons cited by competition authorities to justify these efforts are diverse: identifying restrictions of competition, focussing investigative efforts, increasing effectiveness of competition policy and improving knowledge of particular sectors. In essence, these arguments claim that by setting priorities, detection probabilities are increased.

Competition authorities monitor multiple sectors and have limited budgets. The absence of commitment will then result in a suboptimal allocation of resources. We argue that an appropriate sector specific reward for cartels detected can improve the competition authority's investigative strategy. We conjecture that publicly announcing sector enquiries and publishing their results may also be a way for competition authorities to commit themselves to a particular policy, by making resource allocation observable.

The structure of this paper is as follows. Section 2 first presents a simple model that captures the commitment problem. The competition authority chooses a detection probability for a particular industry with one potential cartel, and the cartel chooses whether or not to collude. Since investigations are costly, from an ex post perspective the competition authority has an incentive not to carry out its threat to investigate the sector. After that, a more realistic model is discussed in which the competition authority has to allocate limited resources among two sectors. In each sector many potential cartels exist, which differ in their stability. Once a the competition authority has deterred a fraction of the cartels in both sectors, it has an incentive to change its investigation strategy and focus on desistance, i.e., on catching cartels that have not been deterred. We show that opportunistic behaviour can be remedied by an appropriate sector specific reward for cartels detected. Section 3 concludes and discusses potential implications of our findings for competition policy as well as possible expansions of our model.

2 Commitment and desistance

This section first describes a basic model that captures part competition authorities commitment problem. In the second, part we drop some of the simplifying assumptions and discuss a more elaborate model.

2.1 Basic intuition

Consider an industry consisting of identical firms which choose whether to collude (C) or to compete (NC). Colluding firms' profits are $\pi^C > 0$, while profits from competition are $\pi^{NC} = 0$. The competition authority can fight collusion by investigating the industry. An investigation policy is denoted by $\beta \in \{0,1\}$, where β is the probability with which the cartel is caught and fined. [2] In this subsection we restrict β to take on the values 0 or 1. The detection probability can therefore alternatively be interpreted as the decision whether or not to investigate. The per period expected profits for an individual firm from collusion are $\pi^C - \beta F$. In this subsection, we abstract from issues concerning the cartel's internal stability and assume that the cartel is stable. [3] The marginal costs of realizing a detection probability β are given by the constant $e > 0$. After a firm has been found guilty, it has to pay a fine F, which we assume exogenously fixed, for example because it is determined by law. Let V denote the welfare gains (or prevented welfare losses) from deterrence of the cartel. The competition authority's objective is to maximize welfare. We assume that $\frac{\Pi^C}{F} < 1$ and $V > e$.[4]

Suppose that the competition authority can commit to a particular investigation strategy (detection probability). It then acts as a stackelberg leader with respect to the colluding firms. The competition authority first chooses a detection probability β, and after observing β the industry decides whether or not to collude. If $\pi^C - \beta F > 0$ the firms collude (choose strategy C) whereas if $\pi^C - \beta F \leq 0$ they compete (choose strategy NC). Since investigating firms is costly, $V > e$, the optimal policy for the government is to set $\tilde{\beta} = 1$. Therefore, if the competition authority can commit, ($\tilde{\beta}$,NC) is an equilibrium and the cartel is deterred

Assume next that the competition authority and the firms move *simultaneously*. One interpretation is, that the competition authority can not commit to a particular investigation strategy, and will ex post deviate from its strategy if that is optimal. Because starting an

[2] In reality, the competition authority first investigates and then prosecutes. We describe this by one probability. We also abstract from the possibility of assessment errors. See Schinkel and Tuinstra (2006) for an analysis of the consequences of such errors.

[3] This implies that we analyse the behaviour of an industry as a single entity. An alternative interpretation is to consider a dominant firm in an industry which has to choose between abuse of dominance or behaving competitively. In the next subsection we will relax this assumption.

[4] The first condition ensures that a cartel can in principle be deterred. The second condition ensures that deterring the cartel would yield positive welfare gains.

investigation is a costly activity, whatever the firms' strategy, the competition authority has an incentive to deviate from its chosen investigation policy. After all, nothing can be gained from the investigation *given* the firms choice to collude or not to collude. If strategies are chosen simultaneously, $\beta = 0$ is therefore a dominant strategy for the competition authority, and if $\beta = 0$, then colluding is optimal for the industry. The unique Nash equilibrium is therefore $\{\beta = 0, C\}$ and the cartel is not deterred.

So far, we have assumed that there are no welfare gains from detecting a cartel. An alternative assumption is that a competition authority does value desistance. Two arguments may support this. First, if firms stop colluding for some time after detection, catching cartels increases welfare. Second, even in the complete absence of welfare gains, competition authorities may value catching a cartel because capturing cartels, unlike deterrence, is observable and may be related to material rewards like a budget increase or exemption from budget cuts and immaterial rewards like status.

Let U therefore denote the value the competition authority attaches to desistance. We assume $U > e$.[5] In equilibrium the cartel must now follow a mixed strategy. If the firms collude, it is optimal for the competition authority to choose $\beta = 1$. However, if the firms compete, it is optimal to choose $\beta = 0$. On the other hand, if the competition authority choose $\beta = 1$, it is optimal for the firms to compete, whereas if $\beta = 0$ it is optimal for the firms to collude. Indeed, if the competition authority values desistance, in the absence of credible commitment the unique mixed-strategy Nash equilibrium is $\{\alpha = \frac{\pi^C}{F}, p = \frac{e}{U}\}$, where α denotes the probability of investigation and p denotes the probability with which the firms collude. The cartel is thus partly deterred.

Note that the probability of colluding, p, is inversely proportional to U. An increase in U therefore reduces the level of collusion. This suggests that the government can partially mitigate the commitment problem by developing a reward scheme for the competition authority which increases U, for example based on the number of captured cartels . Note however, that if U becomes larger than V, the competition authority will prefer desistance over collusion. In a dynamic setting, this may then lead the cartel and the competition authority to collude on some equilibrium where the competition authority and the cartel both earn positive profits, and revert to the mixed Nash equilibrium of the one-shot game forever if the competition authority deviates from its collusive strategy. Another way to realize deterrence, may be to supply the competition authority with a large enough budget, in this case e, followed by sufficiently harsh punishment if the budget is underused, resulting in the competition authority choosing $\beta = 1$. This may correspond closer to reality where most competition authority are provided with fixed annual budgets.

[5] One may wonder whether U can be larger than V. For a welfare-maximizing competition authority U represents solely the welfare gains from desistance. The welfare gains from deterrence will then always be larger or equal, if desistance destabilizes cartels for some while.

This simple model shows that the absence of commitment can in principle severely affect a competition authority's ability to deter cartels. It also suggests that this problem may be remedied, by providing the competition authority with a fixed budget and punishing it for underuse. However, a competition authority monitors multiple sectors and has to allocate its limited resources over these sectors. In the next section, we therefore construct a more representative model of antitrust enforcement in multiple markets by a budget constrained competition authority, to analyse the consequences of the absence of commitment for antitrust enforcement.

2.2 The model

In this section, we consider a competition authority that is active in two sectors, denoted by $i = 1, 2$. Each sector consists of two identical firms competing in prices and producing homogeneous products. The firms choose whether to collude or to compete. If the two firms form a cartel and agree to produce the monopoly quantity, total industry profits equal π^M. The profits of an individual firm from charging the cartel price therefore equal $\pi^C = \pi^M/2$. If the firms compete, Nash equilibrium prices equal marginal costs and both firms earn $\pi^N = 0$. The per period welfare loss due to the cartel equals $B(\pi^C)$. In each industry, the competition authority fights collusion by investigating it. It does this by allocating a particular amount of resources to a sector, which results in a detection probability $\beta \in [0, 1]$ with which the competition authority finds the cartel if the firms collude. After a firm has been found guilty, it will be sanctioned with a fixed fine F, which is determined by law.

Although the competition authority knows what sector the firms are in, it is uncertain about the characteristics of the cartel in each sector. The competition authority has no information concerning firms' profits or the quantities produced. [6] Consequently, from the viewpoint of the competition authority the cartel profit π^C in sector i is distributed between $[0, \infty]$ with a cumulative distribution function $G_i(x)$. For a given detection probability β we define $\pi^*(\beta)$ as the level of cartel profits below which firms compete, whereas all firms with profits above $\pi^*(\beta)$ collude. This implies that by choosing a detection probability β the competition authority deters all cartels with profits in the range $0 < \pi^C < \pi^*(\beta)$. We assume that if caught by the competition authority, a cartel stops colluding for N periods and goes on colluding from period $N + 1$ on, where N is exogenous. Letting δ be the competition authority's discount factor, the total welfare

[6] Besanko and Spulber (1989) assume that the competition authority can observe the quantity produced by firms. Because the competition authority acts as a stackelberg leader, the optimal investigation strategy is conditional on the observed quantity produced.

gain for a given β equals

$$W(\pi^*(\beta),\beta) = \int_0^{\pi^*(\beta)} \frac{B(x)}{1-\delta} dG(x) + \int_{\pi^*(\beta)}^{\infty} g(N,\beta)B(x)dG(x)$$
$$\equiv V(\pi^*(\beta)) + U(\pi^*(\beta),\beta)$$

where we have defined $h(\beta,N) = \beta\delta(1-\delta^N)/(1-\delta)(1-\delta+(1-\delta^N)\delta\beta))$. This measures the number of times a stable cartel is expected to be caught. We denoted the per period welfare gain of deterring a cartel with cartel profits by $B(\pi^C)$, in line with Chen and Rey (2007).[7] Furthermore, $V(\pi^*(\beta))$ denotes the welfare gains due to cartels that are deterred as a result of the competition authority strategy, whereas the second term $U(\pi^*(\beta),\beta)$ denotes the welfare gains due to cartels that desist from their cartel strategy for N periods. Note that the desistance term equals zero for $N = 0$, i.e. if firms do not stop colluding after detection, as it should be.[8]

The two sectors are identical but have different cumulative distribution functions $G_i(x)$. This is meant to describe the notion that the stability of cartels differs between these sectors. The competition authority has a constant, exogenous budget of resources it can allocate among the sectors. The detection probability $\beta_i(t_i)$ is taken to be an increasing concave function of the amount of resources t_i allocated to that sector: $\beta_i'(t_i) > 0$ and $\beta_i''(t_i) \leq 0$. The competition authority maximizes the welfare gains from desistance and deterrence given the budget. Hence, it does not directly care about investigation costs anymore. We assume that the competition authority is subject to a budget constraint $t_1 + t_2 \leq T$, where T is such that it cannot deter all cartels in both sectors simultaneously. Hence, for each feasible allocation of resources over both sectors it holds that $\sum_i G(\pi^*(\beta(t_i))) < 2$.[9]

An investigation policy is defined by the detection probabilities $(\beta_1,\beta_2) \in [0,1]\times[0,1]$, where β_i denotes the detection probability in industry i. The competition authority can choose a detection probability in a given sector by appropriately allocating its resources. This will realize

[7] When deterrence for one period yields benefits B the welfare effect from desistance can be derived from the recurrence relation $V = (1-\beta)\delta V + \beta\delta\left(\frac{1-\delta^N}{1-\delta}B + \delta^N V\right)$.

[8] Explicit expressions for $\pi^*(\beta)$ and $B(x)$ can easily be found. Assume that linear demand is given by $q = a - p/b$ and constant marginal costs are denoted by c. Then $\pi^C = (a-c)^2/8b$ and $B(x) = x$, i.e. the per period welfare loss equals π^C. A distribution over π^C follows for example from a distribution over demand parameter $1/b$ or over production cost c. To derive $\pi^*(\beta)$, note that the firms play a repeated game. In each period, either firm can cheat on the cartel agreement by infinitesimally undercutting the monopoly price charged by the other firm. The cheater then serves the entire market and earns the monopoly profit $\pi^D = \pi^M = 2\pi^C$. We assume punishment for cheating on the cartel agreement to consist of a grim trigger strategy: the firm reverts to the Nash equilibrium forever. The expected cartel profits V_C from following this strategy follows from the recurrence relation $V_C = (1-\beta)\left(\pi^C + \delta V_C\right) + \beta\left(\pi^C - F + \delta^{N+1}V_C\right)$ and equals $V_C = \left(\pi^C - \beta F\right)/\left(1-\delta+\left(1-\delta^N\right)\delta\beta\right)$. Assuming that a cartel that has deviated from the cartel agreement cannot be fined, the profits from deviating are $V_D = 2\pi_C$. For a given detection probability β, the cartel is stable if $V_C > V_D$. Thus the cartel is stable against cheating if $\pi^C \geq \pi^*(\beta) = \beta F/\left(2\delta - 2\beta\delta + 2\beta\delta^{N+1} - 1\right)$

[9] Note that the competition authority deters all cartels in sector i if it allocates an amount of resources $t_i$to this sector such that $G(\pi^*(\beta(t_i))) = 1$.

a welfare gain equal to

$$\begin{aligned} W(\beta_1,\beta_2) &= W_1(\pi^*(\beta_1),\beta_1)+W_2(\pi^*(\beta_2),\beta_2) \\ &= \sum_i [V_i(\pi^*(\beta_i))+U_i(\pi^*(\beta_i),\beta_i)] \end{aligned}$$

If we assume that the competition authority is able to commit to a particular investigation strategy, i.e., to act as a stackelberg leader, it chooses the amount of resources t_i allocated to sector i, taking into account the reaction of cartels to that choice. Equilibrium allocation of resources will therefore solve

$$\arg\max_{t_1,t_2} [W_1(\pi^*(\beta_1(t_1)),\beta_1(t_1))+W_2(\pi^*(\beta_2(t_2)),\beta_2(t_2))] \text{ s.t. } t_1+t_2 \leq T \tag{2.1}$$

However, if the competition authority can not commit to a particular strategy, it chooses the detection probabilities β_1 and β_2 in sector 1 and 2 given the cartel strategies as parameterized by π_1 and π_2 and optimizes only the desistance terms

$$U_1(\pi_1,\beta_1(t_1))+U_2(\pi_2,\beta_2(t_2)) \text{ s.t. } t_1+t_2 \leq T \tag{2.2}$$

In the Nash equilibrium the competition authority chooses optimally given the firms strategies and the firms choose optimally given the competition authorities strategy. The detection probabilities in each sector therefore satisfy

$$(t_1^*,t_2^*) = \arg\max_{t_1,t_2} \sum_i U_i(\pi_i,\beta_i(t_i)) \text{ s.t. } t_1+t_2 \leq 1 \text{ and } \pi_i = \pi^*(\beta_i(t_i^*)) \tag{2.3}$$

Proposition 1. *In the absence of commitment, the Nash equilibrium is to set t_i according to equation 2.3. Welfare will therefore always be less than or equal to welfare in the case of commitment.*

This proposition follows trivially. A competition authority that can commit can always choose the allocation if would choose in the absence of commitment. Therefore, welfare is always less in the absence than in the presence of commitment.

We can identify three special cases when welfare with and without commitment are equal. First, the deterrence effect may equal zero with commitment. This happens if the competition authority cannot deter any cartel. Second, it may be optimal to focus on only one sector both with and without commitment. This happens if collusion is much more harmful and much more stable in one sector than in the other. Third, when both sectors are perfectly symmetric, it is always optimal to locate half of the resources to each sector independent of the ability to commit.

As an example, assume $G_i = I(x-\pi)$ to be a step function. This implies we have two symmetric industries with one potential cartel with profit π^C in each industry. Assume that T is such that the competition authority has sufficient resources to deter collusion in at most one

industry.[10] Denote by β^* the detection probability at which the firms are indifferent between colluding and competing, and by t^* the corresponding amount of resources.

Suppose the competition authority can credibly commit to an investigation policy. If $t^* < T < 2t^*$ and $V(\beta(t^*)) + U(\beta(T-t^*)) > 2U(\beta(\frac{1}{2}T))$ then the best policy is to set $\{\beta_i = \beta^*, \beta_j = \beta(T-t^*)\}$, with $i, j = 1,2$, $i \neq j$. Otherwise the unique best policy is to set $\{\beta_1 = \beta(\frac{1}{2}E)$, $\beta_2 = \beta(\frac{1}{2}E)\}$. This follows because the competition authority can deter collusion in only one industry (because $t^* < T < 2t^*$) and prefers to do so (because $V(\beta(t^*)) + U(\beta(T-t^*)) > 2U(\beta(\frac{1}{2}T))$). If it chooses to deter collusion in industry i, the best policy is $\{\beta_i = \beta^*, \beta_j = \beta(E - e(\beta^*))\}$, since any $t_i > t^*$ does not increase deterrence in industry i while it decreases desistance in industry j, and $t_i < t^*$ does not deter collusion at all. If $T < t^*$ or $V(\beta(t^*)) + U(\beta(T-t^*)) < 2U(\beta(\frac{1}{2}T))$ the competition authority chooses not to deter collusion in either industry. The unique best policy is then $\{\beta_1 = \beta(\frac{1}{2}E)$, $\beta_2 = \beta(\frac{1}{2}E)\}$. This maximizes the total value of desistance because of concavity of $\beta(t)$.

Suppose the competition authority can not commit to an investigation policy. In this case, the Nash equilibrium is given by $\{\{\beta_1 = \beta(\frac{1}{2}E)$, $\beta_2 = \beta(\frac{1}{2}E)\}$, $\{C, C\}\}$. The strategy $\{\beta_1 = \beta(\frac{1}{2}E)$, $\beta_2 = \beta(\frac{1}{2}E)\}$ of the competition authority is optimal given $\{C, C\}$ because of concavity of $\beta(t)$ and $\{C, C\}$ is optimal given $\{\beta_1 = \beta(\frac{1}{2}E)$, $\beta_2 = \beta(\frac{1}{2}E)\}$ since $\beta(\frac{1}{2}E) < \beta^*$. Hence, none of the players has an incentive to deviate from their strategies. Focussing on one sector can never be an equilibrium ex post because this would deter the cartel and it would always be optimal to deviate to the other sector.

It follows that if $T < t^*$ or $V(\beta(t^*)) + U(\beta(T-t^*)) < 2U(\beta(\frac{1}{2}T))$, i.e., the deterrence effect equals zero even if the competition authority can commit, the unique equilibria with and without commitment coincide and opportunistic behaviour does not lead to a suboptimal allocation of resources. However, if $V(\beta(t^*)) + U(\beta(T-t^*)) > 2U(\beta(\frac{1}{2}T))$, although the competition authority has enough resources to deter collusion in one industry, it is not able to do so because of the possibility to behave opportunistically.

In conclusion, if the competition authority can credibly commit to an announced investigation policy, it can optimally deter collusion. However, because cartels, once deterred are no longer of interest for the competition authority, it has an incentive to behave opportunistically. This leads the competition authority to deviate from its the optimal investigation policy by optimizing its utility from desistance. After all, ex post nothing can be gained anymore from the investigation.

Rewarding the competition authority

Now consider whether giving the competition authority an additional incentive depending on the number of cartels caught can lead to an improvement in the competition authorities detection strategies.

[10] This assumption is also necessary for the existence of a commitment problem.

Suppose that the competition authority receives a remuneration R_i per cartel caught in sector i. When the detection probability in sector i equals β_i, the current expected value of the reward received by the competition authority is given by

$$R_i h(\beta_i, N) \int_{\pi^*(\beta_i)}^{\infty} dG_i(x) \equiv R_i N_i(\pi^*(\beta_i), \beta_i)$$

If a competition authority can not commit to a particular resource allocation, an ex post reward can never induce a competition authority to deter *all* cartels in one industry. If all cartels are deterred, ex post it is optimal for the competition authority to reallocate all resources to the other industry. Suppose therefore that in the full commitment equilibrium there are some cartels left in each industry. Consider a symmetric reward $R_i = R$. If R becomes very large, the competition authority will allocate its resources so as to maximize the number of cartels caught. If R_i can be differentiated, all resources can be drawn to either industry by making the reward for catching cartels in that industry very large. If the allocation of resources is continuous in R_i, all value of $t \in (0,1)$ can be realized.

Proposition 2. *Suppose that for any allocation of resources there are some cartels left in each industry. By providing a reward that is differentiated per sector, the competition authority can be induced to choose any allocation of resources. In particular, the optimal allocation can be obtained.*

Proof. Assume that the competition authority only rewards cartels sector 1. The equilibrium allocation solves

$$\arg\max_{t_1,t_2} \sum_i U_i(\pi_i, \beta_i(t_i)) + R_1 N_1(\pi_1, \beta_1(t_1)) \text{ s.t. } \pi_i = \pi^*(\beta_i(t_i^*)) \text{ and } t_1 + t_2 = 1 \tag{2.4}$$

A sufficient (but not necessary) condition for the competition authority to allocate all its resources to sector 1, is that the value derived from received rewards outweighs the decreased value from desistance in sector 2. This is the case if the maximum value from desistance in sector 2 is lower than the value of rewards received when the competition authority allocates all its resources to sector 1. That is $R_1 N_1(\pi^*(\beta_1(1)), \beta_1(1)) > \max_t [U_2(\pi^*(\beta_2(t)), \beta_2(t))]$. Such an R_1 exists if $N_1(\pi^*(\beta_1(1)), \beta_1(1)) > 0$, i.e., if not all cartels are deterred for $t_1 = 1$. An analogous argument for sector 2 holds. Therefore, both $t_1 = 1$ and $t_1 = 0$ can be realized. If the allocation of resources is continuous in R_i, all allocations $t_1, 1 - t_1$ can be obtained, including the optimal allocation. ■

3 Conclusion

Competition authorities are usually treated as unwavering, all-knowing and benevolent. In this paper, we view competition authorities as strategic players in a game of law enforcement and explore the consequences for competition law enforcement if a competition authority cannot commit to an investigation policy and has to allocate limited resources among two sectors. We assume that resources are insufficient to deter cartels in both sectors. If deterrence is realized in one sector, the competition authority wants to reallocate resources to the other if it values desistance in that sector. This opportunistic behaviour leads to a suboptimal allocation of resources.

Providing an incentive to focus on specific sectors, for example by rewarding detection, can reduce the commitment problem. This may be a rationale for given competition authorities yearly targets in terms of a minimum number of cartels to detect. Other measures that can potentially reduce the commitment problem include pre-announcing sector enquiries and publishing their results. This will constrain resource allocations, because a minimum amount of effort is required to produce results. Another possibility is the contractual outsourcing of sectorial studies, thereby restricting possible reallocations of resources. Finally, a competition authority might acquire external financing for investigative efforts in certain sectors. The external suppliers will then require resources to be allocated accordingly, again constraining possible reallocations of resources.

Our analysis lends itself to several extensions. First, the model may be extended to describe a situation where the competition authority can condition its detection strategy on the quantity produced by firms. This would be in line with the work of Besanko and Spulber (1989) Second, it would be relevant to describe a situation where firms cannot observe the detection probability directly, but only the number of cartels caught. They then learn the actual detection probability as time progresses. This may partially solve the commitment problem, as deterrence can then not exist without desistance. A third extension relates to the static nature of our model. We assume that the competition authority chooses β only once. In reality, not only the cartel plays a repeated game, but also the competition authority can choose to reallocate its resources each period. Extending the analysis to a dynamic setting may allow commitment to be supported by the repeated nature of the game. Finding optimal detection strategies in this case relates to an important line of work on mechanism design with collusion. In this literature, collusion is often modelled in reduced form to sidestep issues of information signalling and bargaining under asymmetric information (Laffont and Martimort (1997)). It is a challenge for future work to explicitly model the dynamic interaction between firms and a competition authority in the absence of commitment. Treating competition authorities as regulators but with limited tools and applying insights from the theory of regulation will result in a more realistic theory of competition law enforcement, produce new insights and contribute to the development of more

effective competition policies.

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