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Corporate criminals in a market context: enforcement and optimal sanctions

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Abstract

By combining approaches from the economic theory of crime and of industrial organization, this paper analyzes optimal enforcement for three different forms of corporate misconduct that harm competition. The analysis shows why corporate crime is more harmful in large markets, why governments have a disinclination to sanction firms whose crime materializes abroad, and why leniency for those who self-report their crime is a complement, and not a substitute, to independent investigation and enforcement. As public authorities rely increasingly on self-reporting by companies to detect cartels, the number of leniency applications is likely to decline, and this is borne out by data. Upon a review of 50 cases of corporate liability from five European countries, competition law enforcement, governed by a unified legal regime, is more efficient than enforcement in bribery and money laundering cases, governed by disparate criminal law regimes. Sanction predictability and transparency are higher when governments cooperate closely with each other in law enforcement, when there are elements of supra-national authority, and when the offense is regulated by a separate legal instrument. Given our results, Europe would benefit from stronger supra-national cooperation in regulation and enforcement of transnational corporate crime, especially for the sake of deterrent penalties against crime committed abroad.

Keywords Corporate liability · Corruption · Collusion · Antitrust · Money laundering · Deterrence · Sanctions · Litigation

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1 Introduction

Since the turn of the millennium, governments have sharpened regulations regarding corporate misconduct, including bribery, money laundering, and violations of competition law.[1] At the same time, enforcement systems of corporate liability and sanctioning have become more flexible as a result of a generalization of settlement-based procedures. Since governments are not open about how they rank the many objectives behind the regulation of corporate misconduct, enforcement outcomes are at risk of being exposed to influence from non-legal factors, such as the firm's market position or whether the crime was committed domestically or abroad. This article investigates trade-offs between enforcement strategies, focusing in particular on the difficulty of imposing sanctions that deter corporate crime while at the same time avoiding harmful domestic market consequences. We have found no proper investigation of this trade-off in the literature. By combining the insights from the economics of crime and theories of industrial organization, we are able to analyze its consequences for different forms of profit-motivated corporate crimes and their persistence in a market context. For this analysis we assume that a government's incentives to control corporate crime depends on how it values corporate profits, taking the harmful consequences of the crime into account.[2] Intuitively, this net benefit depends on the geographic distribution of both criminal profits and harmful consequences for consumers. When the consequences materialize domestically, the government's effort to control crime depends on how much it values the interests of consumers versus those of producers – that is, on the extent of benevolence. Benevolent governments will aim to control corporate crime and will prioritize circumstances where the risk of market concentration is high. They will also prioritize large markets, where the consequences of misconduct are more serious. Indeed the analysis shows that *(a) corporate crimes are more damaging in markets of large size.* When the consequences play out abroad, a government (benevolent or not) has few incentives to control the crime.[3] Providing an immediate advantage to home-country consumers, employers, voters, and taxpayers will likely outweigh the longer-term benefit associated with integrity in international markets.[4] We hence

[1] A common declaration in official references to such regulations is that enforcement must be *effective, proportionate, and dissuasive* Although this statement has broad acceptance, its meaning is not clear (Cafaggi & Iamiceli, 2017).

[2] In practice, the government consists of multiple entities and individuals, with different mandates and motivations. The reference to government as *it* and not *they*, thus reflects a crude simplification of reality, albeit common in economic theory focused on defining optimal public policies.

[3] For the sake of mutual legal assistance, a government may see a benefit in contributing to international investigations, if there are media reports of international crimes committed by domestic companies. It may also get something in return for investigating foreign firms whose crimes materialize in its domain. This indirect mechanism is not part of our analysis.

[4] As we investigate incentives on the side of government, our study fits into the line of those that address optimal law enforcement as a two-sided problem, such as Graetz and Wilde (1986) did early, instead of investigating incentives on the side of perpetrators only.

predict that *(b) corporate offenses whose consequences materialize in another country will be tacitly condoned by elected officials, and to the extent that these offenses are investigated and charged at all, we predict that enforcement actions will lead to mild sanctions.* This (international) free-riding problem, which implies inconsistency of sanction practice, calls for stronger barriers to prevent political interference in law enforcement. In such circumstances, efficient enforcement depends on international cooperation, and supra-national enforcement may be more efficient than enforcement at the national level.

In practice, optimal enforcement is challenged by the fact that governments are unable to impose penalties high enough to deter the most profitable forms of crime. However, they always have an opportunity to encourage offenders to cooperate with enforcement agencies by offering a predictable and substantial penalty reduction for corporations that self-report their offenses. We show that *(c) it is easier for enforcement systems to uncover crime through leniency programs than to impose sanctions that will effectively deter the acts.*

Our model opens the black box of corporate incentives to monitor its own involvement in crime. Usually, firms are assumed to be a unitary entity, so when a crime occurs, it happens at the instigation of its management, which is equated with "the firm." The reality is more complex. Corporate crimes are committed by individuals within firms. Not all employees are involved, and corporate management will not always know. In some firms, profit-motivated crime is tacitly condoned by company officials, implicitly, encouraged by their management practices,[5] while in other firms, there is no tolerance to crime. We explore what aspects of public policies may motivate business owners and executives to implement safeguards against corporate crime. When it comes to the structuring of sanctions and liabilities for the sake of inducing corporations to invest in crime-preventive systems and monitor their operations, we show why such ambitions will often fail, even if many policy reports and corporate statements argue to the contrary. In terms of law enforcement, it is impossible to induce firms to adequately monitor their own business practice unless there is a risk of detection by a government agency and an ensuing sanction. Firms' investment in monitoring for crime detection depends on government enforcement (i.e., they are strategic complement), and therefore, for governments, leniency for self-reporting is a complement to self-initiated investigation and not a substitute for it. As a consequence *(d) the number of cases uncovered through leniency programs increases with the authorities' efforts placed in monitoring and enforcement (independent of firms' self-reporting).*[6] Finally, law enforcement, if organized for optimal crime detection, may have a negative effect on competition in concentrated markets, and therefore, even benevolent governments face a difficult trade-off and may seek to shield certain firms from heavy sanctions. This is especially true when highly

[5] Setting unrealistic performance goals, with no corporate culture of crime prevention, will lead some employees to take shortcuts and succumb to corporate crime to improve their performance.

[6] *Effort* in the context of law enforcement refers to the resources and actions dedicated to enforcing laws and fighting crime. It is a critical concept in determining the effectiveness of law enforcement agencies in maintaining public order and deterring criminal activities.

asymmetric penalties are imposed in collusion cases in terms of leniency offered to firms which cooperate first with the authorities. The competitive advantage they win might lead to an increase in sector concentration. Accordingly, *(e) the reliance on leniency in competition cases, including highly asymmetric sanctions, may have a potentially perverse effect on competition.*

Assuming that consequences of crime ought to matter for governments' enforcement priorities (Rose-Ackerman & Palifka, 2016), the theoretical approach provides a benchmark for evaluating law enforcement systems and practices. With an emphasis on European countries, we investigate the extent to which governments are able to secure enforcement of corporate liability in line with the incentives delineated by our analysis. Internationally, the United States stands out as the most active enforcer of corporate liability, including when it comes to cross-border offences, and many countries learn from its approaches. By contrast, there is less information available about enforcement of corporate liability in Europe. This paper contributes to fill that gap. The questions discussed in the theoretical section are explored based on an analysis of a sample of 50 enforcement cases from five different (European) jurisdictions collected for this study. They reveal that, compared to the United States, European enforcement of corporate liability is more heterogeneous across countries. It is also opaque because the information necessary to conduct thorough empirical studies of enforcement practices is not easily available. The information we have been able to gather shows that criminal law enforcement systems perform inadequately assessed against recommendations presented in the theory section. In particular, most enforcement regimes (save for competition law) have a low score with regard to predictability. The review of cases also confirms some of the predictions made in the theoretical sections, in particular regarding the impact of the geographical location of the crime on the sanction level. Moreover, our study of the relationship between the imposition of fines in concentrated markets and later merger cases suggests that heavy fining in concentrated markets may provoke mergers below the threshold for intervention under merger control rules, indirectly causing harm to consumers.

The rest of the article proceeds as follows. Section 2 describes the regulation of corporate liability and points to relevant results in the literature on law and economics. Section 3 presents an economic model for analysis of the above-mentioned trade-offs. First, we describe a general model of corporate crime in a market context, illustrated with an example of collusion. Second, we investigate governments' incentives to control corporate crime in view of how they value producer surplus relative to consumer surplus.[7] Third, we explore optimal sanctions, and especially the use of leniency programs when Becker-style deterrence is not an option. In Sect. 4 we turn to enforcement in practice. By reviewing practices in Germany, the Netherlands, Norway, Sweden, and the United Kingdom, we check whether current enforcement practices in Europe are consistent with the theoretical results. We discuss policy implications and conclude in Sect. 5.

[7] I.e., a government's emphasis of producer and consumer surplus, respectively, is part of this analysis. In practice, producers can also be consumers, yet for simplicity, we write as if two separate groups. We do not apply the sum of producer and consumer surplus as a comprehensive measure of social welfare.

2 Regulation of corporate liability

Governments regulate and sanction corporate misconduct in different ways (Pieth & Ivory, 2011). With the expansion of corporate regulations in the 20th century, it became possible across the United States and Western Europe to hold firms criminally responsible for economic crime committed by their employees. The basis for enforcement was vicarious liability combined with some form of evaluation of responsibility (Oded, 2013). Most countries criminalized corporate bribery in the late 1990 s upon the implementation of international conventions such as the United Nations Convention against Corruption, the Organisation for Economic Co-operation and Development (OECD) Anti-Bribery Convention, and the Council of Europe's Civil Law and Criminal Law Conventions on Corruption.[8] Criminalization of failure to comply with anti-money-laundering regulations (as stipulated by the US Bank Secrecy Act of 1970) started with the US Money Laundering Control Act of 1986; thereafter, other OECD countries followed suit with a largely harmonized combination of criminal and non-criminal regulations, coordinated through the Financial Action Task Force (FATF).[9] Competition in markets is regulated primarily as a non-criminal matter.[10] Today, as a result of EU-cooperation, such regulations are largely harmonized across Europe and is substantially consistent with the even older regulations in the United States.[11]

Normally, criminalization is associated with stricter penalties, a risk of imprisonment for the involved individuals, and compensation for victims. For corporate offenders, it may be followed by indirect consequences such as damages to be settled with business partners, debarment from public procurement, exclusion from some investment funds, and reputational costs. For enforcement agencies, criminalization implies a higher burden of proof, which in many cases means de facto protection against penalties for the offender, especially for individuals who act on behalf of an organization.[12] In practice, however, the distinction between criminal and non-criminal enforcement matters less than one might suppose. The regulatory development has gone in the direction of *functional equivalence*. In other words, corporations can be sanctioned in similar ways, regardless of how the jurisdiction in question combines criminal and non-criminal enforcement (Pieth et al., 2014: 37–40).

The regulatory regimes for corporate liability have evolved in other ways, too, since the turn of the millennium. Around that time, governments started to recognize

[8] The United States was early in criminalizing corporate bribery through the Foreign Corrupt Practices Act (FCPA) of 1977, but enforcement of the act was weak until other countries enacted similar anti-bribery statutes (Garrett, 2020).

[9] See van Duyne et al. (2018) for detailed presentation and analysis of the FATF-initiated AML-regime.

[10] Criminal sanctions against individuals are available in certain jurisdictions, for example the US, UK and Norway.

[11] The US Sherman Antitrust Act of 1890, which still provides a basis for corporate liability in cartel cases, is one of the earliest regulations of this sort.

[12] Especially in cases that end with an out-of-court settlement with a corporate defendant, individuals typically are not charged, according to Garrett (2018), who bases this finding on US enforcement statistics.

the shortcomings in enforcement vis-à-vis corporate offenders, who could easily hide their crimes behind international corporate structures and financial secrecy provisions. Too strict vicarious liability would only serve to strengthen firms' incentives to hide whatever crime they might have conducted, governments realized, and thus such attempts to secure deterrence could harm markets more than it protected them (Arlen, 1994; Khanna, 2000). Today, countries enforce corporate liability with some sort of evaluation of negligence, if not an assessment of guilt (OECD, 2016). This allows enforcement agencies to consider the reasonableness of the penalty in view of the corporation's actual responsibility for misconduct (Hjelmeng & Søreide, 2017; Miller, 2018). While the weight of these circumstances is indeed a question addressed by courts, court assessment of the material facts is costly in complex cases of corporate wrongdoing. It is also a time-consuming process, and society will often be better off if corporate defendants can go on with their business as long as they do so with stronger internal measures against corporate crime. This aim, governments realize, can be secured if corporate offenders can be "rewarded" with a lower penalty if they have in place proper crime prevention systems, self-report their offences, and cooperate with law enforcers. Across countries, such a *leniency* strategy for self-reporting is especially well-developed within the field of antitrust/competition law (Borrell et al., 2014; Wils, 2007), while it might make sense to adapt the strategy for other forms of corporate misconduct too (Arlen, 2020; Bigoni et al., 2015).

Given the widespread adoption of leniency programs by antitrust authorities to combat collusion in markets, economists have conducted extensive research to assess them (see Spagnolo, 2008 and Marvao & Spagnolo, 2018 for a literature review). The overall conclusion of such research is that leniency programs tend to make collusion more difficult. However, researchers also show that there are circumstances in which a leniency programs can facilitate collusion and cartel stability. Buccirossi and Spagnolo (2006) show in a static model that leniency may provide an effective mechanism for occasional sequential illegal transactions that otherwise would not be feasible. Harrington and Chang (2015) show in an infinite horizon model that while a leniency program reduces the duration of cartels in industries where collusion is least stable, it may lengthen the duration of cartels in industries where collusion is easier to sustain. The reason, they explain, is that optimal non-leniency enforcement becomes weaker in these markets due to the limited resources of antitrust authorities. In our study we come to a similar conclusion, which confirms this concern, but the causation channel is different.[13] Together with the results of Harrington and Chang (2015), our findings highlight the importance of enforcement actions that are not prompted by leniency applications.

Governments increasingly allow their law enforcers and corporate offenders to end cases with a *non-trial resolution*, that is, a negotiated settlement that opens for a discretionary evaluation of corporate offenders' compliance system and cooperation with law enforcement (Garrett, 2014; OECD, 2019). Governments defend the

[13] As we will show, public authorities that rely too heavily on self-reporting by firms, will not invest enough in independent detection of corporate crime, and thus, leniency programs will easily fail because firms' incentives to collect evidence and report crime decreases.

practice as a way to align two aims, that of promoting corporate compliance and that of deterring crime (Ivory & Søreide, 2020). Unless the conditions for such enforcement are clearer than what we see today, and the benchmark sanctions higher, there is a high risk that governments will achieve neither of these objectives (Garrett, 2014). For the sake of regulatory efficiency, some governments have started to describe what sort of compliance systems firms ought to have in place to merit lenient treatment under non-trial resolutions.[14] Yet there is substantial uncertainty with respect to current regimes, and the level of informality in these processes is generally high. Settlement-based enforcement normally comes with broad discretion for prosecutors, limited transparency for the public, weak protection against double jeopardy, and criminal sanctions below the level of appropriate crime deterrence.[15]

Governments' ambition to structure sanctions in a way that both promotes corporate compliance and deters crime is largely inspired by economic research on corporate crime (Shavell, 2004, Ch 9 and 10). Enforcement may prevent crime if strict liability with severe sanctions is combined with predictable penalty reductions for certain corporate behaviors (Arlen & Kraakman, 1997; Buccirossi & Spagnolo, 2006; Bigoni et al., 2015; Landeo & Spier, 2020). With respect to sanctions, economists typically consider the total impact of consequences, regardless of legal category (criminal or non-criminal), and take into account both direct and indirect consequences of the penalty, including those beyond the control of enforcement agencies. The crime-deterring impact of enforcement hinges on a sufficiently broad definition of liability, a real risk of crime detection, the predictability of a penalty, and multiple consequences for employees (Arlen, 2020; Polinsky & Shavell, 2000). These criteria apply to settlement-based enforcement as well, yet the added flexibility weakens deterrence if offenders believe they can negotiate themselves out of a serious penalty. It also distorts justice if the difference between the offered sanction and the expected trial result becomes too large for alleged offenders to ever refuse an offered settlement and opt instead for court proceedings (Søreide & Vagle, 2022).

We know less about how enforcement of corporate liability ought to take into account factors such as the perpetrators' market situation, the nature of the crime, and political priorities. A lack of clarity regarding enforcement practices and sanction principles suggests that the barriers against undue influence on enforcement outcomes might be too weak. We need to understand why such influence might happen in relation to different forms of crime, the consequences for markets, and the consequences for optimal regulation. The next section presents a theoretical analysis of these concerns.

[14] The US Department of Justice, the French Anti-Corruption Agency (AFA), and the UK Serious Fraud Office all have provided guidelines on corporate crime preventive measures.

[15] In addition, several authors criticize the cost-saving practice of encouraging firms to investigate their own offenses and provide evidence in order to cooperate with enforcement agencies Baer (2018), Lonati and Borlini (2020). For a survey of settlement-based enforcement in corporate bribery cases in 66 countries, see Makinwa and Søreide (2019).

3 Theoretical analysis

We concentrate on an economic sector with $N \geq 2$ active firms producing a normal good with constant marginal cost c. Assuming these firms produce collectively a quantity $Q(N)$, the net consumer surplus is denoted $S(N) = \int_0^{Q(N)} P(x)dx - P(Q(N))Q(N)$. Let q_i denote the production by firm i and $Q_{N-i} = Q(N) - q_i$. The firm's $i = 1, \ldots, N$ profit is denoted $\pi_i(q_i, Q_{N-i})$ and the sector total variable profit $\pi(N) = \sum_{i=1}^{N} \pi_i\left(q_i, Q_{N-i}\right) = P(Q(N))Q(N) - cQ(N)$. The utilitarian government aims to maximize the objective function:[16]

$$W(N) = S(N) + \lambda\pi(N) \tag{1}$$

where $\lambda \geq 1$ is the weight the government puts on firms' profit compared to net consumer surplus. This weight can reflect macroeconomic concerns, such as employment and taxation, that tilt political objectives toward the industry. More disturbingly, it can be the result of capture by the industry in question. An uncaptured government might set $\lambda = 1$ so as to maximize the net surplus from trade. We analyse the trade-off and coordination problems governments face in controlling corporate crimes (i.e., crimes that benefit a firm by increasing its profits) and the impact of the tools they have at hand.

We are interested in national governments' incentives to control corporate crimes that increase artificially the rents of the firms by stalling competition such as collusion to share markets, money laundering or corporate bribery for procurement contracts.[17] The social "loss" function of stalling competition is:

$$L(N) = W(N) - W(1) = S(N) - S(1) - \lambda\Delta\pi(N) \tag{2}$$

where $\Delta\pi(N) = \pi(1) - \pi(N) > 0$ is the increase in the total profit of the sector when the firms behave like a monopolist. The consumers/users suffer a loss equals to $S(N) - S(1)$, which is larger than the industry extra-profits. It is indeed easy to see that if $\lambda = 1$ then the loss is positive: $L(N) = \int_{Q(1)}^{Q(N)} P(x)dx - c\big(Q(N) - Q(1)\big) > \big(P(Q(N)) - c\big)\big(Q(N) - Q(1)\big) > 0$. Moreover, as long as $Q(N)$ is increasing and concave in N, the loss is also increasing and concave in N.[18] To provide the micro foundations for the loss function $L(N)$, we

[16] See Auriol and Picard (2008) and Auriol et al. (2021) for a discussion of this objective function.

[17] *Money laundering* is the process of concealing the origins, ownership, and/or destination of illicitly obtained funds by integrating them into the legitimate financial system, often through a series of complex transactions, to obscure their criminal origin and make them appear legitimate. *Corporate bribery* is the offering, giving, soliciting, or receiving of any item of value, either directly or indirectly, to influence the actions or decisions of an individual or organization in a business context, typically in violation of legal and ethical standards. *Collusion among competitors* refers to anti-competitive and illegal practice in which two or more competing firms secretly agree to allocate market territories, customers, or product lines among themselves, or manipulate prices, all for the purpose of thereby reducing competition and raising profits at the expense of consumers.

[18] That is $L'(N) = Q'(N)\big(P(Q(N)) - c\big) > 0$ and $L''(N) = Q''(N)\big(P(Q(N)) - c\big) + \big(Q'(N)\big)^2 P'(Q(N)) < 0$ since we focus on normal goods.

consider a simple model of collusion. However, the results presented in Sects. 3.2 and 3.3 are quite general, and do not depend on the specifics of this illustrative example.

3.1 An illustrative example: collusion in markets

We focus on the possibility that firms might collude to raise price and industry profit. To ease the exposition we consider a linear demand, $Q = a - p$, and $N > 2$ symmetric firms competing in Cournot fashion. In equilibrium each firm produces a quantity $q = \frac{a-c}{N+1}$ so that the total production in the absence of collusion is $Q(N) = (a-c)\frac{N}{N+1}$. "Appendix" shows that the loss from collusion is:

$$L(N) = W(N) - W(1) = \left(1 - 2\lambda + 2\frac{N+1}{N-1}\right)\left(\frac{N-1}{N+1}\right)^2 \frac{(a-c)^2}{8}. \tag{3}$$

It can now be confirmed that $L(N) > 0$ if and only if $\lambda < \frac{3N+1}{2(N-1)}$, which implies that the loss is always positive if $\lambda \leq \frac{3}{2}$. Moreover $L(N)$ increases with N iff $\lambda \leq \frac{N}{N-1}$ and is concave in N iff $\lambda \leq \frac{2N-1}{2(N-2)}$. It is, for instance, concave when $\lambda = 1$. In other words if the government values consumer surplus enough (e.g., as much as it values corporate rents), the social loss of collusion is positive, increasing and concave with N. Finally, the harm caused by collusion in (3) increases with the total market size, $Q^* = a - c$. Collusion in a small market is less socially damaging than collusion in a large one. The "Appendix" presents two other simple models, one of bribery and the other of violation of AML regulations, that yield similarly shaped loss functions.

3.2 National government incentives to fight corporate crime

We now examine a government's incentives to implement prevention measures and sanction mechanisms, if any, to prevent corporate crime. For this discussion we assume a benevolent government that aims to maximize net national surplus. We distinguish between two sets of circumstances, one in which the crimes in question are confined nationally, in Sect. 3.2.1, and another, in which the crimes generate negative international externalities, in Sect. 3.2.2.

3.2.1 Social loss of domestic corporate crimes

When a corporate crime is committed domestically, without generating international externalities, a benevolent government will fully internalize it. Since it is not captured by firms potentially involved in the misconduct, a scenario reached by setting $\lambda = 1$, a benevolent government maximizes net consumer surplus. Its incentive to fight corporate crime is then proportional to the national social loss that the crimes are expected to generate, $\tau(N)L(N)$ where $\tau(N)$ is the probability that a crime occurs undetected.

On the one hand, the preceding analysis reveals that the loss $L(N)$ increases in N when $\lambda = 1$. Stalling competition is more damaging for consumers when markets are not concentrated. In very concentrated markets, firms have market power anyway, and even when their prices are regulated, they enjoy some rents. So when they stall competition, collude or make corrupt deals, the loss for consumers is, all else being equal, smaller. On the other hand, these crimes are more likely to occur in concentrated markets than in more competitive ones. This is especially true of collusion, where coordination and enforcement become more difficult as the number of conspirators increases.[19] If offences are carried out more easily under circumstances of few competitors, it means that in general $\tau(N)$ should be decreasing in N. Therefore the net effect of an increase in N on the expected social loss is ambiguous. In what follows we show how these conflicting forces interact.

Proposition 1 *Let $\lambda = 1$. Assume that $\tau(N) \in [0, 1]$, the probability that the corporate crime goes undetected, is strictly decreasing and log-concave in $N \geq 1$ with $\tau(1) > 0$ and $\lim_{N \to +\infty} \tau(N) = 0$. The expected social loss from corporate crime, $\tau(N)L(N)$, is increasing for $N \leq N^*$ and decreasing for $N > N^*$, where $N^* > 1$ is so that*

$$\tau'(N)L(N) + \tau(N)L'(N) = 0 \tag{4}$$

Proof See "Appendix" □

The examples of losses defined in (3) (but also in (14), and (16) in "Appendix") are log-concave. In fact they are concave when $\lambda = 1$, which is stronger than log-concave. Now if the probability of the crime going undetected $\tau(N)$ is also log-concave, then the expected social loss from corporate crime, $\tau(N)L(N)$, is first increasing and then decreasing, and therefore reaches a maximum for some finite value of $N > 1$.

To keep the exposition simple, this analysis abstracts from the complexity of how criminals interact and sustain their illegal deals, so that $\tau(N)$ is a black box. Here, we provide a discussion of the microfoundations of the function and how it can be endogenized.[20] This function will generally depend on the specificity of the crime and the market being studied. For instance, if a public procurement corruption deal or a money laundering case involves a firm while excluding its N competitors (see "Appendix"), the firms excluded from the illegal agreement may learn about it and complain. If there is a chance $p \in (0, 1)$ that each firm excluded from the corrupt deal becomes a whistle-blower, then $\tau(N) = (1-p)^N = exp\big(Nlog(1-p)\big)$, which is decreasing, log-concave. More generally, all functions such that $\tau(N) = exp(-\rho N)$ with $\rho > 0$ are log-concave, and the result of proposition 1 holds.[21]

[19] See for instance Motta (2004) and Combe and Monnier (2010) for empirical evidence on cartel size in the EU.

[20] We are grateful to an anonymous referee for suggesting this discussion.

[21] When $\tau(N) = exp(-\rho N)$, the value of N^* is such that $L'(N)/L(N) = \rho$: the market structure conducive of the largest social damage is relatively concentrated and decreases with ρ. Substituting, for instance, the

Another example concerns collusion in markets. Since it involves $N > 1$ firms, collusion raises a coordination problem. Each firm has an incentive to deviate from the collusive agreement to maximize short term profit. So in a static context collusion unravels, unless the cartel uses other means to enforce its illegal agreement, such as violence or blackmailing (Buccirossi & Spagnolo, 2006). The illustrative example in Sect. 3.1 can easily be extended to address the commitment problem. We assume that the game is repeated ad infinitum and that the firms' discount factor is $\delta \in [0, 1]$. Firms play a "grim-trigger" strategy of playing the collusive output until one firm deviates, then keep to the competitive strategy forever after that. The "Appendix" shows that in a stationary environment without any randomness, collusion is an equilibrium if δ is sufficiently large (i.e. if firms are patient and place sufficient value on future profits):

$$\delta > \frac{(N+1)^2}{(N+1)^2 + 4N}. \tag{5}$$

To account for randomness in markets, we assume that in each period there is a shock ϵ^t IID across period with 0 mean and distribution function $F(\delta)$ so that collusion breaks down if $\delta \leq \frac{(N+1)^2}{(N+1)^2+4N} - \epsilon^t$. The RHS of Eq. (5) being increasing in $N > 1$, sustaining collusion is harder when N is large: collusion unravels with probability $F\left(\frac{(N+1)^2}{(N+1)^2+4N} - \delta\right)$. With a uniform distribution on $[-\delta, \delta]$ with $\delta \geq 0.5$, $\tau(N) = 1 - \frac{(N+1)^2}{(N+1)^2+4N}\frac{1}{2\delta}$, which is decreasing and concave in N.[22]

In other words, under general assumptions, the expected social loss from corporate crime, $\tau(N)L(N)$, reaches its maximum for some value $N^* > 1$. Moreover, it increases with Q^*, the size of the market, since $L(N)$ increases with the market size. A benevolent government that wishes to control domestic corporate crime ideally should tailor its efforts to the specific sector under consideration. In particular, enforcement agencies should give priority to oligopolistic sectors, where the market concentration is relatively high, where collusion and corruption are real threats, and where the market size is large enough for anti-competitive practices to substantially harm consumers/taxpayers. This implies that *governments need sanctions guidelines that allow law enforcers to take the market situation into account in cases of corporate crime.* This pragmatic case-by-case approach seems optimal when the government is benevolent, but should not come with the cost of reduced sanction predictability.

Footnote 21 (continued)

loss function (3), N^* is such that $N^3 + 3N^2 - N - 3 - \frac{8}{\rho} = 0$. For $\rho \to +\infty$, $N^* = 1$, for $\rho = 0.5$ $N^* \simeq 2$, for $\rho = 0.1$ $N^* \simeq 3.62$. Similarly, substituting the value from (14), yields the function $N^* = \sqrt{2/\rho + 1}$.

[22] With a uniform distribution collusion unravels with $Prob\left(\epsilon \leq \frac{(N+1)^2}{(N+1)^2+4N} - \delta\right) = \frac{(N+1)^2}{(N+1)^2+4N}\frac{1}{2\delta} < 1$ $\forall$ $\delta \geq 0.5$.

3.2.2 International externalities of corporate crime and domestic profit

Now we turn to corporate crime that generate negative externalities in foreign countries – collusion to share international markets, violation of anti-money laundering regulations and bribery conducted to win public contracts abroad being different cases in point. When negative externalities occur outside a country, while the extra criminal profits reaped by corporate offenders increase the country's gross domestic product, a benevolent government will have very few incentives to control the problem. From this country's perspective, there is only a fiscal cost to be paid in this effort for international integrity, and no direct benefit to be reaped - at least not in the short run.[23] Unless there is strong international solidarity in society, punishing these firms harshly for their crime is unlikely to be popular among voters, who are both employees and taxpayers. In this case the government will favor domestic firms' rent over foreign consumer surplus. We establish easily the following proposition.

Proposition 2 *If* λ, *the weight the government puts on the corporate sector rent*, *is larger than* $\tilde{\lambda} = \frac{S(N)-S(1)}{\Delta\pi(N)} > 1$ *then the "loss"* (2) *from corporate crimes is a gain*: $L(N) < 0$.[24]

Proposition 2 implies that if the crime occurs in another country without creating much distortions on the domestic market, a government under political pressure, such as an upcoming election, will put a very small weight (i.e., close to 0) on the interests of foreign consumers/taxpayers, or alternatively, a very large (i.e., infinite) weight λ on domestic firms' profits so that the "loss" (2) from corporate crimes is a gain: $\lim_{\lambda\to+\infty}\left(\tau(N)L(N)/\lambda\right) = -\tau(N)\Delta\pi(N) < 0$. It generates new taxes and employment at home, while the harm (to taxpayers or consumers) is abroad. Committing resources to investigate and sanction the extraterritorial criminal behavior will easily be perceived as a cost to domestic producers and taxpayers, while benefiting primarily foreign societies and competitors. Unless there is strong international solidarity in society, punishing these firms harshly is unlikely to be popular among voters, who are both employees and taxpayers. *We therefore predict lax enforcement of punishment for corporate crimes that hurt consumers and taxpayers in a foreign country.*

In the enforcement of antitrust law, the US and the EU, as well as most other jurisdictions, base their competence on the so-called "effects doctrine", although the respective interpretation varies. This basically means that conduct or cooperation in question may be targeted by the competition authorities provided that it produces effects at the territory within jurisdiction, regardless of whether the infringement

[23] For the sake of a clear analysis, we highlight the difference between crime happening at home and abroad. In practice, all countries are somewhat affected by crime that happens elsewhere. Still, we think it makes sense to assume that governments are concerned and eager to act against primarily the offences that materialize within their country's borders. Likewise, citizens - who are also voters - are more affected by crime that happens locally.

[24] For instance, the "loss" in (3) is negative whenever λ is larger than $\tilde{\lambda} = \frac{3N+1}{2(N-1)} > \frac{3}{2}$.

took place outside that territory.[25] However, if the infringement takes place within the jurisdiction but produces effects *only in third countries* (e.g., export cartels) the antitrust rules will not apply extra-territorially.[26] In other words, in matters of antitrust the result of proposition 2 is a principle of law.

This is a typical free-riding problem insofar as the loss is spread across several jurisdictions while the benefit accrues to one country. Accordingly, unless there is a coordinated international intervention to control such international corporate crimes with economic sanctions large enough to make it socially unprofitable for the country benefiting from them, the problem is likely to continue unabated. As illustrated by the "effects doctrine" in antitrust law, or by the tense discussions around taxation of multinationals and remedies to curb their fiscal "optimization" practices, the difficulty lies in the intergovernmental process toward coordinated international action.

Nonetheless, large economies, such as the European Union (EU) and the United States, are in position to unilaterally impose sanctions that are big enough to curb the incentives of countries benefiting from the crimes. They can induce other countries to internalize the negative externalities they generate when they condone certain forms of crime that benefit themselves at the expense of other societies. The United States is in a stronger position than most to issue threats to other countries and impose sanctions on international corporations. They have for instance forced Switzerland to enhance financial transparency and cooperate in investigation of tax matters (see Church, 2016). Similarly, the EU's listing of non-cooperative tax jurisdictions has triggered changes in countries known to offer financial secrecy and has contribute to promote fairer taxation.[27] In the European Union, the existence of supra-national authorities such as antitrust bodies help also coordinate sanctions against those crimes that harm any EU members.

3.3 Deterrence of crime through optimal sanctions: leniency programs and precautionary measures

The goal of this section is to analyze what a benevolent (i.e., uncaptured) public authority should do to combat corporate crime. This provides us with a model of optimal enforcement and a benchmark against which to compare actual practices and sanctions. We focus on domestic crimes which a benevolent government has an incentive to control (i.e., $\lambda = 1$). We examine the optimal structure of the sanctions that the government should inflict on firms to curb them. The government set a sanction scheme that apply to all firms. For legal equity concerns it cannot ex-ante favor one firm over the other.[28] Since the N firms are symmetric, it implies that in

[25] See, with a comparison between the US and EU approach R. Whish and D. Bailey: Competition Law, 10th ed. 2021 pp 516-526.

[26] See US Supreme Court in Nabisco (579 U.S. 321 (2016): most conduct that "causes only foreign injury," excluded.

[27] For details, see press release on "Fair Taxation: EU publishes list of non-cooperative tax jurisdictions."

[28] Ex-post sanctions might be different depending on the behavior of firms.

equilibrium they react to the government incentives in the same way. To ease on notation we therefore drop the firm's index when computing its reaction to the sanction scheme in Sect. 3.3.1.

3.3.1 Self-reporting and deterrence

Compared to a law enforcement agency, corporate management is far better positioned to monitor crime committed by its firm's employees or other representatives. The firm has two types of tools available for the monitoring of crime committed by employees. First, it can invest ex-ante $K \geq 0$ in preventive measures that will make the detection of crime easier for all parties (e.g., double-checking/endorsing of sensitive information and clearance procedures, digitization to safeguard all actions and corporate information exchanges, software to perform monitoring in real time, procedures to facilitate whistleblowing, etc.). Second, the firm can invest $m \geq 0$ to monitor employees on a daily basis. The probability that the firm will discover crime when committed, $p^f(m/K) \in [0,1]$, is increasing and concave in $m \geq 0$ for all $K \geq 0$. We assume that precautionary measures ease the monitoring of crimes $p^f(m/K_1) > p^f(m/K_2)$ when $K_1 > K_2 \geq 0$ and $m > 0$. Finally, $p^f(0/K) = 0$ for all $K \geq 0$. In other words, the firm must invest in some monitoring if it aims to detect corporate crime.

The government too can detect corporate crime, but is less efficient than the firm in this task because it is external to the firm's operations. Let $p^g(m/K) \in [0,1]$ be the probability that the government finds out that a corporate crime has been committed when such a crime has in fact occurred. We have $p^g(m/K) \leq p^f(m/K)$, $\forall m > 0$. As for the firm, preventive actions make crime detection easier: $p^g(m/K_1) > p^g(m/K_2)$ when $K_1 > K_2 \geq 0$ and $m > 0$.

Taking the perspective of the representative firm, we focus on its gain/loss from reporting corporate crime. Let $F > 0$ be the base fine – that is, the fine in cases where the firm did not report the crime while there is also no evidence that it tried to cover it up. Let $F^h \geq 0$ be the fine in cases where there is evidence that the firm detected the crime and hid it. Finally, let $F^r \geq 0$ be the fine in cases where the firm reported the crime to the authorities. This implies that if a corporate crime is committed, and $\beta \in [\frac{1}{N}, 1]$ is the firm's fraction of the rent, then the firm's expected profit is (see "Appendix"):

$$\begin{aligned} E\pi =& \beta\pi(1) - \left(1 - p^f(m/K)\right)\left(p^g(m^g/K)F\right) \\ & - p^f(m/K)\left(\mathbb{1}_{\{r\}}F^r + \mathbb{1}_{\{h\}}p^g(m^g/K)F^h\right) \end{aligned} \tag{6}$$

where $\mathbb{1}_{\{r\}}$ equals 1 if the firm reports the crime and 0 if it does not, and $\mathbb{1}_{\{h\}}$ equals 1 if the firm hides the crime and 0 if it does not. The standard Beckerian model of crime deterrence is obtained simply by setting $K = m = 0$ so that $p^f(m/K) = 0$. In this case (6) becomes $E\pi = \beta\pi(1) - p^g(m^g/K)F$. Let $\pi(N)$ be the firm's profit when it behaves honestly. Crime is deterred if and only if $E\pi \leq \pi(N)$, or equivalently:

$$F \geq \frac{\beta\pi(1) - \pi(N)}{p^g(m^g/K)}. \tag{7}$$

Since monitoring is costly for the government, it is optimal to set m^g as close as possible to 0 so that the punishment F goes to infinity (see Becker, 1968). The problem with this Beckerian solution is that it fails to capture limited liability and bankruptcy constraints. The firm will never pay the infinite penalty,[29] and therefore, the expected loss from corporate crime is not large enough to prevent the crime when $p^g(m^g/K)$ is small.

We consider how a more sophisticated approach to sanctions, one that strengthens firms' incentives to cooperate with law enforcers, might improve the detection of crime, although it is not necessarily sufficient to prevent the crimes from taking place. Assuming that a corporate crime has been committed and the corporate management has become aware of it, which occurs with probability $p^f(m/K)$, the firm will cooperate with the authorities if and only if the expected cost of doing so, F^r, is lower than the expected cost of hiding the crime, $p^g(m^g/K)F^h$:

$$p^g(m^g/K)F^h > F^r \geq 0. \tag{8}$$

Equation (8) shows that, as long as $p^g(m^g/K) > 0$, it is always possible, by differentiating punishment, to induce firms to cooperate with the authorities when they discover crime in their operations. Indeed, whatever the maximum value of the fine F^h that can be imposed on the firm when it has covered up the crime, the government can always decide to set $F^r < p^g(m^g/K)F^h$. For instance it can choose to grant full leniency in case of self-reporting by setting $F^r = 0$. Consistent with results by Spier (1992) and Bigoni et al. (2015), differentiated treatment of offenses can help uncovering the occurrence of corporate crime. By contrast if Eq. (8) is violated so that $F^r > p^g(m^g/K)F^h$ then the firm never reports a crime.

We deduce that if the government wants the firms to invest in monitoring, sanctions must be set so that (8) holds, in which case there is an interior solution $m^* > 0$ solution to

$$\frac{\partial p^f(m/K)}{\partial m}\left(p^g(m^g/K)F - F^r\right) = c'(m) \tag{9}$$

This allows us to establish the following result.

Proposition 3 *If $p^g(m^g/K)F > F^r$, then private monitoring $m^* > 0$ solution of (9) and public monitoring $m^g > 0$ are strategic complement*:

[29] For instance, according to EU Council Regulation (EC) No 1/2003 of 16 December 2002 (rules on competition) Article 23.2: "For each undertaking and association of undertakings participating in the infringement, the fine shall not exceed 10% of its total turnover in the preceding business year". And Statistics from the European Commission demonstrate that the majority (i.e., 56,12 % excluding immunity recipients) of undertakings fined receives a fine below 1% of the annual turnover.

$$\frac{dm^*}{dm^g} = \frac{-p_m^f(m/K)p_m^g(m^g/K)F}{p_{mm}^f(m/K)\left(p^g(m^g/K)F - F^r\right) - c''(m)} \geq 0. \tag{10}$$

If $p^g(m^g/K)F \leq F^r$, *then* $m^* = 0$.

Proof See "Appendix". □

Proposition 3 implies that private monitoring m^* increases with public monitoring m^g. We predict that *the probability that a firm monitors, uncovers and reports corporate crime increases with the effort made by the government to monitor its activities*. Unless corporate management is aware that its firm's operations are monitored it will have too weak incentives to commit resources for the sake of efficient policing of corporate activities. Government investment in monitoring, for example by providing sufficient budget for enforcement agencies and encouraging or rewarding whistleblowers, is an essential public good for ensuring market integrity (see also Harrington & Chang, 2015).

The discussion so far has focused on the structure of sanctions, which should encourage firms to cooperate with the authorities, assuming a crime has been committed. An important question is whether, by optimizing this structure, the government can deter crime completely. The next Proposition shows that, in general, it cannot.

Proposition 4 *Corporate crime is deterred if and only if*:

$$\beta\pi(1) - \pi(N) \leq p^g(m^g/K)F - p^f(m^*/K)\left(p^g(m^g/K)F - F^r\right) \tag{11}$$

where m^* *is solution to* (9) *if* $p^g(m^g/K)F > F^r$ *and* 0 *otherwise*.

Proposition 4 shows that governments face a dilemma in its efforts to control corporate crime. On the one hand, optimal deterrence occurs when $m^* = 0$ so that (11) becomes $\beta\pi(1) - \pi(N) \leq p^g(m^g/K)F$.[30] Everything else being equal (i.e., for a given p^g), condition (11) will not ease the standard Beckerian deterrence condition (7): the probability of detection by the government must be large enough to deter firms from committing corporate crime. On the other hand, when deterrence fails, Eq. (8) shows that to induce firms to cooperate with an enforcement agency it is necessary to differentiate punishment depending on whether the corporate management reports the crime when it is discovered in the firm's operations or not. The differentiation of punishment decreases the sanctions' deterrent impact in (11). *Leniency programs that differentiates punishment to secure firms' cooperation with enforcement agencies do not ease the deterrence condition; on the contrary, they*

[30] That is, the maximum deterrence occurs when the right hand side in (11) is maximum. This requires that $p^g(m^g/K)F \leq F^r$ so that $m^* = 0$ and $p^f(m^*/K) = 0$, which implies that (11) becomes $\beta\pi(1) - \pi(N) \leq p^g(m^g/K)F$.

make it more binding. In other words, the structure of the fines that encourages companies to invest in monitoring and to cooperate with authorities, $p^g(m^g/K)F >> F^r$, conflicts with the goal of deterring them from committing crimes, which requires $p^g(m^g/K)F \leq F^r$. We deduce the next result.

Corollary 1 *The government should set* $F = F^h = F^r = \overline{F}$ *so that* $m^* = 0$ *if* $p^g(m^g/K) \geq \frac{\beta^j \pi(1) - \pi(N)}{\overline{F}}$. *It should set* $F = F^h = \overline{F}$ *and* $F^r = 0$ *so that* m^* *is maximal otherwise*.

Corollary 1 shows that, if the probability of detection by the government is large enough to deter firms from committing corporate crime, then there is no need to waste private resources in daily monitoring and preventive measures. The government does not introduce a leniency program and firms have no incentive to commit crime, nor to report any. By contrast if the probability of detection by the government is too low to prevent crimes from occurring when punishment is maximal, then the government should encourage firms to monitor and report crimes to the authorities by offering leniency in case of self-reporting. Leniency programs are an implicit admission that crime deterrence does not work. An interesting result of the Corollary 1 is that there is no incentive benefit to differentiate penalties based on whether or not the firm knew about the offense when it did not report it: $F = F^h = \overline{F}$. It means that once a crime is uncovered without the help of the firm, there is no need for the government to commit resources to investigate the firm thoroughly to determine the management's ex ante awareness of the crime: m^* in (10) is independent of F^h. *It is sufficient for incentive reasons to offer leniency in case of self-reporting and the same level of punishment otherwise (i.e, it is sufficient to have* $F^r < F = F^h$).[31]

3.3.2 The limits of leniency programs

Antitrust authorities in the United States and in the EU rely heavily on leniency programs to uncover cartel cooperation. According to Carmeliet (2012), the vast majority of EU cartel infringements are discovered through a leniency program. Ysewyn and Kahmann (2018) conducted a review of cartel cases decided under the Commission's 2006 Leniency Notice, and finds that for most years since then, 100% of investigations were sourced from immunity applicants. As shown in Proposition 3, the incentive effect of offering leniency for those who self-report corporate crime depends critically on governments' ability to uncover and sanction such offences on its own. In the EU, there is a risk that the Commission and the antitrust enforcement agencies at the national level are relying too heavily on leniency programs to

[31] We do not argue here that corporate liability should be strict (in the sense that guilt should not be required on the part of the firm or from persons acting on behalf of it). In any case, the European Court of Human Rights recently held that strict liability in a criminal law context would be contrary to the European Convention on Human Rights (G.I.E.M v Italy, app. no. 1828/06, Grand Chamber judgement of 28 June 2018, para. 242). Our point is simply that the management's ex ante awareness should not impact on the size of the penalty.

uncover cartel cooperation, which we predict should lead to a decrease in the number of reported cases. As far as we know we are the first to establish such a link between nonleniency enforcement efforts made by anti-trust authorities and the number of immunity applications.[32]

Over the last years there has been a noticeable decrease in the number of immunity applications from firms operating in a cartel, and thus, a possible weakening of the Commission's ability to detect cartels. By reference to statistics from Global Competition Review, Ysewyn and Kahmann (2018) document a clear decline in the number of leniency applications between 2014 and 2016. According to them, the number of leniency applications (including immunity applications) fell by almost 50% over three years.[33] While such statistics are difficult to obtain in detail in Europe, there are indications that this might be a trend.[34] Even if the Covid-19 crisis might explain part of the dip in the last period, recent surveys confirm that practitioners have seen a decrease in interest from their clients to apply for leniency before the pandemic (see for instance Wils, 2017). According to the OECD's Trends in Competition 2023 report, leniency applications have hence steadily declined over the past seven years worldwide (from nearly 600 in 2015 to fewer than 200 in 2021; see OECD, 2023).

The second concern raised regarding leniency programs ability to uncover collusion, is the consequences of such asymmetric sanctions on the market structure and competition. In cases of cartel cooperation, the firm that self-reports its offence can get full immunity (i.e., a fine $F^r = 0$) and, on top of that, a competitive advantage if its competitors are all sanctioned.[35] To illustrate the anti-competitive effect of leniency programs, consider the sanctions of corollary 1, $F^r = 0$ and $F = F^h = \overline{F}$, so that the self-reporting corporation profits from a stronger market position after reporting the crime, as its competitors are weakened by the sanction. Assuming the firms face a random shock in their operations affecting their financial viability, ξ^i independently and identically distributed in $(0, +\infty)$ according to the density $g(\xi)$ and the c.d.f $G(\xi)$, the firm i goes bankrupt if the fine is larger than ξ^i. The proportion of firms impacted by the penalty that goes bankrupt is: $Prob\left(\xi^i \leq \overline{F}\right) = G(\overline{F}) > 0$. We deduce the next result.

[32] Harrington and Chang (2015) show very interestingly that a leniency program can result in *more* cartels, and this can occur at the same time that a leniency program is generating many applications. In our case we predict a low number of applications, which does not reflect more integrity, just less detection.

[33] From 46 leniency applications in 2014, it dropped to 32 applications in 2015, and then to 24 applications in 2016.

[34] This is for instance evidenced by statistics on leniency applications published by the German Federal Cartel Office: 37 applications in 2017, 25 in 2018, 16 in 2019 and only 13 in 2020 (see Annual Reports of the German Bundeskartellamt). Such statistics are not readily available from other competition authorities.

[35] For the self-reporting firm there is no guarantee that any competitor will be sanctioned, and governments sometimes also offer benefits for the second and third cartel members if they cooperate with enforcement agencies. According to EU statistics for the last five years there were 80 out of 441 cases where a firm received zero penalty (immunity) but a larger number of cases where the penalty is between 0 and 0.99% of global turnover; statistics available here (last page): https://ec.europa.eu/competition-policy/cartels/statistics_en.

Proposition 5 *If a leniency program with fines* $F = F^h = \overline{F} > 0$ *and* $F^r = 0$ *works as intended then after the imposition of the fines there are in expectation* $EN^c = 1 + (N-1)\left(1 - G\left(\overline{F}\right)\right) < N$ *firms left to serve the market.*

Proof See "Appendix" □

In other words, every thing else being equal, *concentration rises following the asymmetric treatment of the guilty firms in the context of a leniency program.* To the best of our knowledge this prediction is new in the literature on leniency, which tends to assume that the number of firms is fixed/stationary. Whether this predicted positive correlation between cartel sanctions and higher concentration holds in the EU context is an empirical question to which we will return later.[36]

3.3.3 Optimal investment in precautionary measures

The analysis related to Proposition 4 revealed that in general, enforcement systems are unable to deter firms from committing corporate crimes. Since monitoring corporate crime is easier and less costly when corporate preventive measures are in place (i.e., when K is larger), the government ought to require firms to take precautionary measures to ensure transparency and induce employees to report crime to the authorities (Arlen & Kraakman, 1997). For instance, a government might require a minimum level of K, which ought to be verifiable, either as a condition to warrant leniency in case of self-reporting, or simply as a mandatory legal requirement. Not investing adequately in crime prevention ought to be considered ex-post as corporate negligence, implying a risk of harsher sanctions and criminal prosecution against individuals.

The optimal level of prevention measures solves: $\min_K \{L(N)\tau(N/K) + NK\}$. If the probability that a crime goes undetected, $\tau(N/K)$, is decreasing and convex in K then this problem is well behaved (i.e., the minimisation problem is convex),[37] and the first-order condition is also sufficient. We deduce the next result.

Proposition 6 *Let* $\tau(N/K)$ *be decreasing and convex in* K*. The optimal investment in precautionary measures,* K^* *is such that*:

$$\frac{-\partial\tau(N/K)}{\partial K}L(N) = N \tag{12}$$

At the optimum, the marginal benefit of increasing K in terms of crime reduction, which is proportional to the loss $L(N)$, should be equal to the marginal cost of

[36] When it comes to other crimes such as corruption or money laundering, there is rarely such substantial asymmetry in law enforcement consequences for involved partners.

[37] This would be for instance the case if, conditional on the government investing $m^g = \overline{m}$ in monitoring effort, each firm has a probability $p^f(m/K)$ of being a whistle-blower increasing and concave in K. Then $\tau(N/K) = \left(1 - p^f(m^*/K)\right)^N$ where m^* is solution to (9) and $p^g(\overline{m}/K) = 1 - \left(1 - p^f(m^*/K)\right)^N$.

increasing it, which is N, the number of firms active in the sector that would all have to bear the cost K. We next study how the optimal level of preventive measure varies depending on the market size Q, and the intensity of competition N. We also study how the critical value N^* defined in Proposition 1 is impacted by K.

Appendix shows that since $L(N)$ increases with the size of the market Q, as illustrated for instance by (3), it implies that precautionary measures should be larger in larger markets: $\frac{dK^*}{dQ} > 0$. By contrast, the impact of the sector concentration, as measured by N, on the optimal level of precautionary measures is ambiguous. On the one hand, when N is larger, precautionary measures are socially more costly as each firm needs to pay K. On the other hand, assuming the cross-derivative of τ with respect to N and K is negative, the marginal benefit of preventive measures K on the expected social loss $\tau(N/K)L(N)$ increases with N the number of firms active in the sector, pushing up the optimal level of K. Appendix shows that, depending on which of this effect dominates, the optimal level of precautionary measures might increase or decrease with N. Finally, and importantly, we ask whether precautionary measures are useful to control corporate crimes. To answer, we need to study how N^* defined in Proposition 1 varies with K. Assuming that the cross-derivative of τ with respect to N and K is negative, "Appendix " shows that increasing preventive measures decreases N^*. Minimizing social loss by imposing preventive measures of level $K^* \geq 0$ defined in (12) on firms, decreases their ability to commit a corporate crime that will go undetected. In other words, *imposing preventive measures K^* solution to* (12) *limits the number of firms that can conspire without being detected, and therefore, the extent of corporate crimes.*

4 Enforcement in practice

In this section, we consider whether real life's enforcement conditions in the EU, the largest integrated economic zone on earth, correspond to the theoretical results developed above. For this exercise we consider different sources of information. Obtaining relevant data, however, has proven difficult. Detailed facts about enforcement cases are generally shielded from public scrutiny, including from researchers. Evaluating public enforcement of corporate liability is made even more difficult by the use of non-trial resolutions, for which documentation is far more limited than for court proceedings, and where the calculation of the sanction is often poorly substantiated if it is described at all.

For our case studies we selected five countries - Germany, the Netherlands, Norway, Sweden, and the United Kingdom. For the three areas of corporate liability that we investigated – corruption, money laundering, and violations of competition law (some places referred to as antitrust), countries in Northern and Western Europe have similar regulations, as described in Sect. 2, and this applies to our case countries as well.[38] Nonetheless, European jurisdictions differ in important ways with

[38] Norway is not an EU member, but as a party to the European Economic Area (EEA) Agreement it is required to comply with relevant EU legislation on a similar basis as Member States of the EU.

respect to both regulatory details and enforcement practice, and in the choice of countries, we capture some important differences. The UK is a common law country, with a stronger plea bargain tradition than the other four countries. Germany is a federation with slightly different practices across its 16 federal states, while criminal law is exclusively a matter of national regulation and enforcement. Sweden and Germany have yet to introduce corporate criminal liability, although enforcement of non-criminal corporate liability is functionally equivalent, as described in Sect. 2. Although such aspects matter for regulatory performance, we simplify our presentation by focusing on specific features of enforcement as they are reflected in the research material and as they compare to the Sect. 3 results.

Considering the mentioned five countries, we conducted a search of their legal databases as well as other publicly available databases, supplemented by a general internet search using search engines. Further information was gathered by contacting relevant authorities in the five jurisdictions, with follow-up phone calls as well as formal applications for access to decisions for the purpose of research. This investigation, carried out between June and November 2019, yielded a total of 50 non-criminal and criminal corporate liability cases, including 20 competition law cases, 19 bribery cases, and 11 AML cases (listed in the "Appendix"). We studied this information, along with complementary data, in order to explore the empirical side of our theory's implications.[39]

Given the 50 cases and the five jurisdictions, we were able to verify at least some of the predictions put forward in Sect. 3. Namely, we investigate the predictability of sanctions and (partly) leniency across jurisdictions (4.1) in order to verify whether the basic assumptions for a well-functioning enforcement system are present. With a view to governments' incentives, we also explore the relevance of market size and market structure in the sample of cases as well as the geographical location of the consequences of crime (4.2). This is both related to the question about social loss (3.2.1), as well as governments' inclination to prosecute crimes that are carried out abroad (3.2.2). In a sub-study of competition law cases at the EU-level, for which more facts are available compared to the other two sorts of offences, we investigate the market consequences of a sanction (4.3). The latter section explores the concern of competitive harm stemming from asymmetric treatment of corporate offenders, as demonstrated in (3.3.2).

4.1 Predictability of sanctions and leniency

It follows implicitly from the analysis above, as well as general insights from the economics of crime, including those derived in Sect. 3, that an enforcement system's ability to deter future crime requires a certain ex-ante predictability of sanctions. Potential offenders ought to know what actions are subject to criminal liability

[39] Apart from a sub-study where we investigate the market impact of sanctions, we do not make use of EU competition law cases from the European Commission when comparing enforcement practices in national jurisdictions.

and how the liability is enforced. Likewise, for leniency to spur crime detection as described in Sect. 3, it must be possible for self-reporters to rely on the enforcement agency to reduce the penalty in return for cooperation. Predictable use of the leniency policy is thus essential for its intended impact. With respect to law enforcement more generally, a high degree of predictability implies lower discretionary authority, and thus, less opportunity to deviate from optimal enforcement strategies, including sanction levels. Predictable sanctions requires access to facts about corporate offences (unless such facts are available it is impossible to know whether the imposed sanctions keep a level high enough to deter crime or not). Law enforcement predictability and access to information about the offences committed are therefore relevant for several of the points made in the theoretical analysis.

Based on the information we collected about country enforcement systems, we placed countries on a 1-5 scale (where 1 is the best score) along these two dimensions of facts availability and predictable leniency, as shown in Table 1. The country scores are also broken down by type of offence (bribery, AML, antitrust). The scores are the result of our systematic assessment of the regulations and enforcement practices in the 50 cases reviewed (see "Appendix" for details on their computation). On the left-hand side of Table 1, the country scores reflect the extent to which facts about corporate misconduct and sanctions are available to the public and presented in a manner that makes it possible to assess the proportionality between penalty and corporate misconduct. The harder it is to learn the facts, the higher the score. In countries that score 1, the public has complete access to information about the crime and the sanction, while in those that score 5, it is not even possible for researchers to apply for access to such basic information. The right-hand side of the table presents our scores on the ease with which offenders can predict the sanction reduction (i.e., leniency) they will receive if they self-report and cooperate with law enforcement agencies. Clear guidelines made public and demonstrated application of stated principles in cases earns a score of 1. The score increases the closer we get to a situation where firms have no clear information about the use of sanction reductions upon self-reporting and there is no systematic use of leniency demonstrated in the case material. Hence, Table 1 illustrates variation across the five countries in the extent of access to information about enforcement practices and the clarity with which law enforcers offer leniency to those who self-report.

On each of the two dimensions, we find sanction predictability to be greater in competition law cases than in corruption or AML cases. Information about sanctions is more available to the public in antitrust cases, and the benefits offered to firms that self-report are more predictable. In this respect, enforcement of competition rules seems better aligned with economic ideas of incentives to report crime than enforcement of anti-bribery laws and AML regulations. One likely explanation is the presence of a European supra-national enforcement agency (the Directorate-General for Competition, or DG Comp) in the case of antitrust and the systematic cooperation between competition agencies within the European Competition Network (ECN). There is no equivalent for enforcement of anti-bribery laws and AML regulations. In addition, the rules and conditions for leniency are spelled out much

Table 1 Sanction predictability

Country	Facts availability			Predictable leniency		
	Bribery	AML	Antitrust	Bribery	AML	Antitrust
Germany	4	5	2	4	5	2
Netherlands	4	3	1	3	3	2
Norway	4	2	2	4	4	2
Sweden	3	2	2	4	4	2
United Kingdom	3	2	1	3	2	1

The results on each of the two dimensions of sanction predictability are presented along a 1-5 scale, where a lower score reflects clearer consistency with deterrence (i.e., a better performing system). For details on the computation see "Appendix"

more clearly in legal instruments and case law, bringing about harmonization as well as predictability across jurisdictions.[40] For the sake of predictability, there is limited discretion with regard to negotiated settlements in cartel cases; either a firm will meet the conditions for leniency, or it can accept a cartel settlement under a procedure adopted in 2008 (with a maximum reduction in the fine of 10 percent).[41]

With respect to bribery and AML-cases, sanction predictability is not only a matter of how well rules are aligned, but also the 'flexibility' with which enforcement agents enforce the regulations. The more discretionary authority (i.e., flexibility) associated with law enforcement, the less predictable the sanctions. Although such flexibility might be used to optimize sanctions, it likely reduces the deterrent effect of sanctions if it implies reduced sanction predictability.

Enforcement flexibility depends on several factors, such as the content of regulations, the relevant agencies' de facto and de jure independence, and most importantly, enforcement agencies' ability to conclude cases without a trial, turning instead to a settlement, formally referred to as a *non-trial resolution*.[42] For insight into such variations across the five case countries, we consider the results of a recent survey of regulatory regimes for non-trial resolutions in corporate bribery cases, conducted by the International Bar Association for 66 countries. These data were used to construct a Prosecutor Discretion Index (Søreide & Vagle, 2020). PDI scores for our five case countries are shown in Table 2. This index indicates the position of criminal law enforcement agencies, which is normally responsible for pursuing corporate bribery and AML cases (and not, non-criminal regulation, like competition law cases).

[40] See, for example, the Model Leniency Programme adopted by the ECN.

[41] See Commission Regulation No. 622/2008. There is more flexibility with regard to commitments under Regulation No. 1/2003, Article 9, where the European Commission has power to make commitments offered by firms legally binding. However, that procedure is not applicable in cases where the Commission intends to impose a fine.

[42] When it comes to corporate liability, the otherwise substantial difference between criminal regulation and non-criminal/administrative regulation is less pronounced. This is because of the above-mentioned practice of functional equivalence, the use of fines as the main penalty, and an increasing consideration of compliance-based defense. Therefore, for our purpose, we can compare systems regardless of the criminal/non-criminal distinction.

According to these results, prosecutors' discretionary authority is higher in the Netherlands than in the other four countries, and lower in the UK. The UK has the most explicit regulations for the use of non-trial resolutions, and it is the only jurisdiction that requires judicial review of such enforcement actions. However, in some of the cases reviewed, such as the Rolls Royce bribery case and the XYZ/Sarclad case, the enforcement processes have spurred debates about too-soft treatment of firms that might be considered strategically important by the government.[43] Nonetheless, the regulatory space for flexible enforcement is at least as broad in the other countries. The Netherlands has fewer regulations when it comes to the use of non-trial resolutions, and often appears lenient with corporate offenders (Makinwa, 2014). Germany and Sweden, on the other hand, have no criminal liability for corporate offenders, and despite strict criminal law procedure, the lack of explicit regulations on non-trial resolutions give their enforcement agencies more leeway when it comes to corporate liability cases. Similarly, Norway has no stipulated principles for non-trial resolutions and no judicial review of such enforcement actions. Taking into account governments incentives, as found in Sect. 3, such leeway might be counterproductive with respect to maximization of consumer surplus.

Summarizing our observations of sanctions predictability across the five case countries, we find far more consistency in enforcement practices in competition law cases compared to bribery and AML violations, regardless of enforcement mode, as reflected by the low scores for antitrust in Table 1. The scores presented in Table 2 apply to the enforcement in corporate bribery cases, yet the scores are relevant for AML cases too. Here we find the enforcement systems of the UK and Sweden being the least flexible with respect to corporate liability, and according to Table 1, comparing all three offences, these two countries have the highest sanction predictability in general as well. Among the five case countries, the Netherlands have the most flexible enforcement in corporate liability cases, and probably, the lowest sanction predictability. Generally, our results are consistent with the fact that prohibitions on bribery and money laundering are subject to the more traditional regimes of criminal law, and such rules are not subject to enforcement at an EU level. Competition law, by contrast, implies that EU Member States are required to introduce legal instruments similar to the powers of the European Commission in their legal orders, and this applies to leniency programs and cartel settlement procedures. Upon this comparison, we find *the enforcement procedure and outcome are more predictable where independent specialized agencies have operated for a long time with supranational cooperation and oversight, and with a clear aim of encouraging offenders to self-report.*

[43] This was so also in the case against BAE Systems, a British defense producer (which is not part of the 50 cases in our review). Then Prime Minister Tony Blair, despite clear evidence of crime, stopped investigation of corruption in December 2006, claiming that enforcement of anti-bribery law in this case went against the public interest by undermining British jobs and contracts abroad.

Table 2 Prosecutor discretionary authority in corporate bribery cases across the case countries

Country	Prosecutor Discretion Index	Opportunity to skip the case	De jure bargaining freedoms	De facto bargaining freedoms	Ex-post monitoring
Netherlands	3.50	4.0	4.0	4.0	2.0
Norway	2.75	4.0	1.0	2.0	4.0
Germany	2.25	1.0	1.0	3.0	4.0
Sweden	2.25	2.0	1.0	2.0	4.0
England &Wales	1.75	1.0	1.0	3.0	2.0

The Prosecutor Discretionary Index (Søreide and Vagle 2020), shown in the data column on the far left, presents the arithmetical average of the scores in the other four columns. The lower the score, the less flexibility there is for prosecutors who enforce corporate liability by means of non-trial resolutions

4.2 Market size, sanction size, and the geographic location of crime

In this Section, we explore two central issues raised in the theoretical part; the relationship between sanctions and social loss (considering market position and market size), and the predicted reluctance of governments to prosecute crimes abroad.[44]

For sanctions to make a crime unrewarding, the penalty level divided by the risk of detection (expressed as a variable below 1) must exceed the gain from the crime. Clearly, the offenders in the 50 cases considered were not deterred by the risk of a sanction. From the outset, however, we do not know if the reason was recklessness as to the criminal nature of the conduct, a miscalculated risk of detection, an anticipated sanction level below what it would take to make the crime unrewarding, an assumption that if detected, one can negotiate oneself out of the problem by accepting a non-trial resolution, or simply, too little information about enforcement to make such calculations.

Therefore, we want to know if the sanctions in the cases considered held a level high enough to deter similar crime in the future, although in practice, it is difficult to estimate the necessary variables. The detection rate is impossible to quantify correctly unless we know the actual amount of crime incidents. The burden of a penalty is not expressed by the size of the fine alone; it also includes the enforcement process, the payment of damages, the indirect consequences of the case, and any charges brought against employees and business partners. Not all these facts are known, and those that are available are not necessarily shared with the public, not even for research. The details of the cases and the extent of the information we were able to collect are presented in Table 6 in the appendix.

In 26 of the 50 cases, we were not able to obtain reliable information on the final sanction. For the other 24 cases, we have a rough estimate of the gain from crime and the financial size of the corporate fine. Considering these figures we calculate

[44] It should be noted that for competition law infringements most jurisdictions are based on the "effects doctrine", and only outlaw conduct having an effect within their own territory.

the minimum detection rate required for the penalty to deter crime, assuming the penalty is known to firms. For example, in a cartel case from 2012 against Virgin Atlantic Airlines (VAA) and British Airways (BA), VAA reported the offense, and upon leniency received no penalty. Here the sanction principle applied appears to be consistent with the aim of having the firms cooperating with the authorities (as expressed in Sect. 3.3.1 Eq. 8) because VAA was rewarded fully for self-reporting. Meanwhile, BA received a fine of £58.5 million, and the enforcement agency estimated that BA had a £29 million gain from the offense. For the penalty imposed on BA to deter crime, however, the detection rate must have been nearly 50 percent, which we consider unrealistically high. Therefore, we conclude that the fine imposed on BA was too low for the penalty to deter future cartel cooperation. In a similar manner, and with an assumption that any detection rate above 25 percent is unrealistic, we find that the fines might be high enough to deter similar crimes in a similar situation in seven of the cases, and too low in 17 of the cases, as categorized in Table 3. The letters *b*, *l* and *c* refer to the sort of offence, i.e. bribery, laundering (AML) and competition law, while the letters *a* and *h* in the parentheses behind the shortened case-name refer to geographical location of consequences, i.e. abroad and home, as we return to below.

Among the cases where the offender was given a relatively low fine, twelve are bribery cases (Rolls Royce, XYZ/Sarclad, Siemens, Airbus, MAN Ferrostaal, DB Schenker, Ballast Nedam, VimpelCom, Telia, SBM Offshore, Standard Bank (2015-case), and Yara); four are AML cases (ING Groep, Santander, DNB, and Sædberg); and two are competition law cases (Asphalt and the above-mentioned airline price-fixing case). Cases where the penalty might be high enough to deter the offense include three competition law cases (Dutch Railways, TeliaSonera, and the case against Ragn-Sells AB and Bilfrakt Bothnia AB), two bribery cases (Smith & Ouzman and Standard Bank 2015-case), and two AML cases (Santander and Deutsche Bank). Yet the estimated gain is very uncertain in the AML cases. Hence, this material indicates that *penalties are often below the level necessary for deterrence in bribery and AML-cases, and appear more likely to reach the level of deterrence in competition law cases* (i.e., they are larger). One explanation might be the more explicit regulation of the calculation of sanctions in competition law cases, a matter we will return to below.

Given the theoretical results of Proposition 1, we also wanted to check if the size of sanctions (i.e., whether considered high or low) varied systematically with the offender's market position. Calculating the ratio between market concentration and sanctions size is not straightforward. Estimates of market concentration are often uncertain because they require identification of a market, and this is complicated for multinationals that operate across industries. Furthermore, crime is more likely in concentrated markets, as predicted in Sect. 3, and this may lead to systematically higher sanctions. Moreover, as we have described above, a penalty that appears to be low might be a result of the offender's self-reporting, thus consistent with the theory on leniency.

Considering our 50 cases we could estimate the ratio between penalty and market position for 26 of them. For the assessment of concentration, we use the Herfindahl-Hirschman index score, when such information is available, and otherwise, the

Table 3 Market concentration and severity of penalty

	High penalty	Low penalty
Concentrated	Ragn-Sells and Bilfrakt (*c*, *h*)	British Airways (*c*, ?)
	Deutsche Bank (*l*, *a*)	Rolls Royce (*b*, *a*)
	Standard Bank 2015 (*b*, *a*)	XYZ/Sarclad (*b*, *a*)
	Dutch Railways (*c*, *h*)	Airbus (*b*, *a*)
	TeliaSonera (*c*, *h*)	MAN Ferrostaal (*b*, *a*)
	Santander (*l*, ?)	ING Groep (*l*, *a*)
		Yara (*b*, *a*)
		VimpelCom (*b*, *a*)
		Telia (*b*, *a*)
		DNB (*l*, ?)
		Koppang (*l*, *h*)
Not concentrated	Smith & Ouzman (*b*, *a*)	Siemens (*b*, *a*)
	SBM Offshore (*b*, *a*)	DB Schenker (*b*, *a*)
	Ragn-Sells AB and Bilfrakt (*c*, *h*)	SBM Offshore (*b*, *a*)
	Svenska Förpacknings (*c*, *h*)	Ballast Nedam (*b*, *a*)
		Sædberg and Hodne (*l*, *h*)

Letters *b*, *l* and *c* refer to bribery, AML and competition law crime, respectively, while *a* and *h* refer to abroad and home. High penalty corresponds to cases where the ratio between the fine and the estimated gain from the crime is bellow 0.25. They are classified as low penalty otherwise. See Table 6 in the "Appendix" for details

concentration ratio (Alexeev & Song, 2013; Cavalleri et al., 2019). For each case, we estimated the mark-up ratio for the specific offenders, as a modified Lerner index, and checked for relevant remarks from market analysts and government. Based on this scant material, Table 3 shows in the upper-right quadrant of the matrix those offenders that both operated in concentrated markets and received a relatively low penalty. We find there are more cases of corporate liability in concentrated markets than in markets where firms are exposed to tougher competition, consistently with Proposition 1. In this material, the cases where the penalty is clearly below a level able to deter crime outnumber the cases where the penalty might be at a level high enough to prevent future crime. Whether powerful firms are shielded from sanctions is difficult to tell on the basis of these cases, although Table 3 shows firms operating in concentrated markets are often treated too mildly by law enforcers. Regarding the sectors that happen to be included in our material, banks appear to be more severely sanctioned than other types of businesses (given this set of cases), while defense producers and telecommunication operators have received low penalties. When it comes to variation across the jurisdictions, the ratio between low and possibly deterrent penalties shows Sweden (0/3) and the UK (3/3) are the more likely to impose severe sanctions, while Germany (5/0), the Netherlands (5/0) and Norway (4/1) are the jurisdictions most inclined to impose low penalties.

We also wanted to check whether the geographical location of the crime has an impact on the sanction imposed.[45] We categorize the cases listed in Table 3 according to crime happening abroad (*a*) or at home (*h*). Among the 16 cases playing out abroad, for which we have evaluated the level of sanctions, only four cases (25%) resulted in a penalty that might have been high enough to deter future crime, while 12 of them resulted in a low penalty. In contrast, in the seven cases where the consequences harmed the domestic market, five cases (72%) resulted in a tough penalty, while in two of the cases the penalty was low. In this material, there is a clear overweight of low penalties when the consequences of crime materialize abroad. If there is a tendency to shield powerful firms from heavy sanctions, these cases show, it happens more frequently when they are liable for bribery in a foreign market than when they are implicated in cartel cooperation or AML violation, regardless of market concentration.[46] In sum, consistently with the prediction of Proposition 2, *crimes for which the consequences materialize abroad, especially bribery cases, are sanctioned less severely than the other categories of offenses.*

4.3 The impact of sanctions on competition in markets

A problem for governments that are accountable and want to sanction offenders fairly is the risk that the sanction itself may have harmful market consequences. This concern may help explain why governments sometimes seem to shield corporate offenders from sanctions. To understand whether the sanctions themselves make a difference in markets, we collected data on antitrust cases at the EU-level. Information about (de facto) sanction principles is far more available for cartel cases than for criminal cases because the European Commission provides detailed information about all its cases.

Reviewing all antitrust and cartel cases in the period from 1 January 2010 to 10 March 2020, we found 89 cases that resulted in a formal decision. In 73 of the cases that resulted in a sanction, the offenders operated in a clearly distinguished sector (with a unique NACE code), and that fact allowed us to consider systematic variation across sectors. We focus on these 73 cases. Considering 3,363 merger and acquisition (M &A) cases,[47] we first find that the average number of M &As is 18.1 in the sectors where an offender is fined for anti-competitive behavior (with a median of 11), while it is 8.1 in other sectors (with a median of 4). This finding suggested a pattern across sectors of M &A cases being far more common (nearly double) in sectors where one or more firms have been sanctioned for anti-competitive

[45] It is recalled that in competition law, the competition authorities are barred from enforcing the rules if the effects solely occur abroad.

[46] As we are interested in the specific jurisdictions' inclination to impose sanctions that deter crime, we have not included any additional sanctions imposed by other jurisdictions in the same case. Therefore, it cannot be ruled out that the total corporate penalties in a given case was higher than what is described (although such sanctioning remains limited by the *ne bis in idem* (double jeopardy) principle).

[47] This material is limited to cases notified to the EU Commission under the European Merger Regulation.

Table 4 Correlation between sanctions and M &A cases

	Number of M &A Cases by level 4 NACE codes								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sanction	0.802*** (6.26)	0.634*** (4.58)	0.401** (2.47)						
Time				0.110*** (6.29)	0.088*** (4.65)	0.056** (2.54)			
Log(Fine)							0.039*** (4.65)	0.042*** (4.79)	0.028*** (2.62)
Constant	2.093*** (47.13)	0.745*** (2.82)	0.764*** (2.61)	2.095*** (47.48)	0.743*** (2.81)	0.762*** (2.60)	2.095*** (47.77)	0.744*** (2.81)	0.763*** (2.60)
Mean of outcome variable	9.24	9.24	9.35	9.24	9.24	9.35	8.76	8.76	8.87
Sector-Level 1 (19 categories)	No	Yes	No	No	Yes	No	No	Yes	No
Sector-Level 2 (84 categories)	No	No	Yes	No	No	Yes	No	No	Yes
Number of observations	643	643	634	643	643	634	627	627	618

The table shows the results from regressions using a generalized linear model

t statistics in parentheses $^{*}P < 0.1$, $^{**}P < 0.05$, $^{***}P < 0.01$

behavior, compared to other sectors.[48] To investigate the strength of the pattern we run linear regressions, which methodology is detailed in "Appendix". The results confirm a highly significant difference in the rate of M &A between industry groups (identified by their specific NACE code) with and without a sanction. Several versions of these linear regressions were run to assess the effect of a sanction on the M &A rate. Results are shown in Table 4.

First, we define a dummy variable equal to 1 if a sanction has been applied and regress it on the number of M &A cases that occurred during the period studied. We observe in the first column that on average, the number of M &A cases increases by a factor of 2.23 (= exp(0.802)), which corresponds to 9.98 additional cases when a sanction has been imposed (relatively to cases with no sanction). Since M &A is driven by industry-specific forces and not solely, nor even primarily, by sanctions imposed by competition authorities, we control in a second and third specification for the industry in which M &A takes place. In the specification presented in column 2 we use the level 1 of the NACE code (19 broad categories) as a control. In the specification of column 3, we use the level 2 of the NACE code (84 categories). As expected the coefficient of sanction is smaller when we control for sector characteristics. However the sanction dummy remains large (at 0.634 with 19 sector controls; 0.401 with 84 sector controls) and highly significant. This implies that on average, the number of M &A cases increases by a factor of 1.5 (= exp(0.401)).

Second, we check the robustness of this base result by using other measures for the sanctions. In columns (4), (5) and (6), we reproduce the same analysis as in columns (1) to (3), using the duration between the date of the first fine and the end of the period studied (10/03/2020), so that when no sanction was imposed the value of "Time with sanction" is 0 and strictly positive and increasing when sanctions were imposed earlier, instead of the sanction dummy, with and without the NACE codes. Finally, in columns (7), (8) and (9), we run the same regressions with the log of amount of the sanction as an independent variable. These two robustness checks confirm a higher M &A frequency in sectors where firms have been subject to antitrust sanctions. The three set of regressions yield similar and consistent results.

This result might reflect in part the market structure as formalized in the theory: there appears to be a clear over-representation of firms sanctioned in high-concentration markets (i.e., they are characterized by a low N which implies in the theory that the probability of collusion is higher). For example the fined sectors contain a higher number of cases related to network utility sectors, such as production and trade of electricity and gas, industries that are already more concentrated by nature, akin to their natural monopoly characteristics (see "Appendix"). Markets prone to cartelization are also presumably more inviting to horizontal mergers as well, as collusion requires coordination and cooperation between firms. These illegal agreements might be a stepping stone for more formal ones, i.e., acquisitions and mergers.

To further explore the heterogeneous effect of sanctions on sectoral mergers and acquisitions, we interact Sector with Sanction. To avoid having too many interaction

[48] We are indebted to Wouter P. J. Wils (King's College London/European Commission) who suggested we might want to check this pattern.

terms, we group the level 1 sectors that do not have enough observations together: sectors C, D, H, J and K have enough observations to be kept, while the other are grouped together. The interaction effects in column 4 in Table 7 show that sector C (Manufacturing) and Sector J (Information and Communication) deviate significantly from the omitted category, which is evidence that in sectors C and J, the Sanction effect on M &A is higher than in the other sectors. From these observations we infer that, indeed, the sectors play an important role in explaining the impact of Sanction on the number of M &As.

To conclude, competition authorities may intervene against M &As that are harmful to competition, but the standard for intervening under, for instance, the EU Merger Regulation – "a significant impediment of effective competition"[49]–implies that mergers may inflict a loss on society long before the threshold for intervention is met, as illustrated by the fact that Sanction seems to increase significantly M &A in sectors such as Manufacturing. For governments, it would be wise to take such concerns into account when imposing sanctions on corporate offenders. However, under the current state of law, a reduction in the level of fines in order to prevent future M &As in the market would not be permissible.[50]

5 Discussion

Internationally, and particularly in OECD countries, we are witnessing a rapid evolution in corporate liability regulation and sanctioning practices. In this article, we have explored the relationship between the nature of a corporate crime, the market position of the offender, and policy priorities. Our analysis combines classical findings in law and economics with insights from theories of industrial organization and places the challenges of law enforcement in a political economy context. On this basis, we explain why regulation and enforcement are often sub-optimal and why sanctions are not structured optimally. Our results disclose room for improvement with respect to government priorities in crime control, their sanction principles, and organization of law enforcement institutions. Specifically, the results in Sect. 3.2.1 suggest that governments should set their investigative priorities to target the offenses with the most harmful impacts on society. The consequences of corporate misconduct are more serious in large markets, especially when the crime distorts competition in markets. Yet the cases reviewed in Sect. 4.2, where relevant information was available, did not show a nexus between market size/market structure and the level of the sanction, indicating that the social loss plays a modest role in enforcement policy. We also show in Sect. 3.2.2 that in some circumstances governments prefer to shield domestic corporations from sanctions. Consistently with the insights from the theory, the empirical study illuminates the lack of internalization of international crimes. It should be noted that in competition law infringements

[49] Regulation No 139/2004 Article 2(3).

[50] See the EU Commission's guidelines on the level of fines in cartel cases.

inflicting harm solely in foreign markets are formally excluded from the geographical scope of the rules.

Governments are not open about these enforcement practices. Drawing on our case material from Europe, we find enforcement of criminal law regimes suffers from a lack of predictability of the outcome of proceedings. Although the use of non-trial resolutions allow for an often desired enforcement flexibility, both deterrence and implementation of leniency mechanisms require predictability. Most of the regimes in the sample perform poorly regarding the recommendations set forth in Sect. 3.3.

On this point, competition law, with detailed and harmonized rules on the calculation of fines and leniency, stand out from the criminal law regimes governing corruption and money laundering. However, the number of leniency applications has dropped over time, and this trend might indicate, on the basis of the predictions from Sect. 3.3.1, that enforcement resources are not spent optimally. Furthermore, the sample of cases in the empirical study does not indicate that offenders' implementation of precautionary measures plays a role in enforcement; offenders are not rewarded for such measures, nor is the absence of such measures sanctioned, contrary to the recommendations in Sect. 3.3.3.

Enforcement practices are more efficient when they are subject to supranational regulation and enforcement. Across our selection of cases, sanction predictability and transparency are higher when governments cooperate closely with each other in law enforcement, when there are elements of supra-national authority, and when the offense is regulated by a separate legal instrument. Such features of enforcement reduce the risk that governments will act less forcefully against offenses whose consequences materialize abroad. Hence, the results of our analysis and review show why accountable governments ought to accept international oversight and enforcement for international cases. In that respect, the European Union's supra-national regulation for competition in markets is a success.

With respect to bribery and AML offences, Europe might benefit from the presence of an authority like the Federal Bureau of Investigation (FBI) in the United States. In spring 2020 several movements in such a direction took place. The European Union established the European Public Prosecutor's Office, an independent EU body with competence to investigate and prosecute crimes that harm EU finances, including at the level of Member States. Europol launched a new European Financial and Economic Crime Centre that will enhance the operational support provided to EU Member States and EU bodies in the fields of financial and economic crime and strengthen financial investigations. In the same period, the European Commission published an ambitious and multifaceted action plan for AML regulation and enforcement. While these initiatives are promising, the development of efficient enforcement mechanisms has been too slow, in large part because governments want to keep control of their criminal law regulations. This barrier to efficient enforcement of corporate misconduct suggests that such offenses ought to be regulated in

non-criminal ways, in addition to whatever criminal prosecutions countries may choose to pursue.[51]

Appendix

Modeling corporate crime losses: bribery and violation of AML regulations

Corruption in public purchases: bribery

To illustrate the social cost entailed by corruption in public purchase, we assume that a commodity or service of fixed size Q is to be purchased on behalf of the government (i.e., the people) by public tender, and the commodity will be paid for using taxpayers' money. We assume that $S(Q)$ is large so that the net social surplus (1) associated with the public acquisition is always positive (i.e., it is always worth procuring the commodity). To produce a quantity $q_i \geq 0$ the firm $i = 1, \ldots, N$ faces the cost $C_i(q_i) = c_i q_i$ where the c_is are independently and uniformly distributed in [0, 1]. Since the firms' cost parameters are independently and identically distributed, it is optimal under asymmetry of information to organize a second-price auction (Myerson, 1981). The expected transfer paid for the commodity with such a competitive bidding procedure is $t(N) = \frac{2Q}{N+1}$ while the net profit expected by a producer when being one of N bidders is $\pi(N) = \frac{Q}{N(N+1)}$ (see Auriol & Soreide, 2017).[52] It implies that the net expected social welfare in (1) is: $W(N) = S(Q) - \frac{2Q}{N+1} + \lambda\frac{Q}{N+1}$.

By contrast, if corruption occurs, and if one firm manages to capture the public purchaser so that it implements sole sourcing instead of a fair competitive procedure (see Auriol, 2006), the acquisition cost is equal to the monopoly price $t(1) = Q$, and the firm's expected rent is $\pi(1) = \frac{Q}{2}$.[53] The principal's surplus is $W(1) = S(Q) - Q + \lambda\frac{Q}{2}$. The firm's rent from bribing the public purchaser to win the contract is therefore

$$\Delta\pi^b(N) = \pi(1) - \pi(N) = Q\frac{N(N+1)-2}{2N(N+1)} > 0 \quad \forall N \geq 2. \tag{13}$$

We deduce that the social loss of corruption is:

[51] Rui and Søreide (2019) explain the benefits of non-criminal vs criminal regulation for these sorts of corporate offences.

[52] Auriol and Soreide (2017) explore the market effects of debarment as a sanction for corruption in an infinite-horizon repeated procurement game. Debarment is found to make little difference in markets with high competition, while in markets with low competition it may deter corruption as long as firms value public procurement contracts in the future and there is an appreciable risk that the corruption will be detected.

[53] The rent will be shared between the firm and a bribe payment. If the bribe takes the form of an illegal transfer to a decision-making official, such a bribe would typically be small compared to other figures in the corporation's calculations. If the bribe is made as a political donation, it will be larger but is often subject to tax exemption.

$$L^b(N) = W(N) - W(1) = \left(\frac{2-\lambda}{2}\right)\frac{N-1}{N+1}Q. \tag{14}$$

The loss from bribe, $L^b(N)$, is strictly positive, increasing and concave in $N \geq 2$ when $\lambda < 2$. It varies between $L^b(2) = \left(\frac{2-\lambda}{2}\right)\frac{Q}{3}$ and $\lim_{N\to+\infty} L^b(N) = \left(\frac{2-\lambda}{2}\right)Q$. Indeed, when the number of bidders increases, they collectively bid more aggressively. This reduces the final purchase cost, thereby increasing consumers'/taxpayers' net surplus. If the government cares enough about consumers/users so that $\lambda < 2$ (i.e., if the weight placed on the corporate sector relative to the consumer surplus is not too large), it will value this social benefit. Moreover the loss increases with Q, the size of the market. Intuitively when the market is small, it is not essential to secure a low unit price, as the total bill will be low anyway. By contrast, when the quantity to be procured is very large, it is crucial to obtain the lowest possible per-unit price. Any increase in the unit price paid for the commodity translates into large surcharge for taxpayers. Finally, if $\lambda > 2$, the "loss" is actually a gain: when the government is captured by the corporate sector, it favors monopoly distortion and rent over consumer surplus.

Money laundering: violation of AML regulations

Banks failure to comply with AML regulations, which means money laundering can occur, is a different offence compared to corruption in public procurement or collusion in markets because the social loss related to money laundering is quite external to the sector itself and is often diffuse at the international level, as the main impact of money laundering is to facilitate organized crime, global financial criminality, financing of terrorism, and tax evasion. In other words, on top of the distortions of competition in the banking sector it generates, money laundering creates negative externalities, often at the international level. In the absence of money laundering, the social surplus is as defined in (1) with $Q(N)$ resulting from the fair competition between the banks. For instance, if they enjoy some market power and play Cournot, in the linear demand case studied above it yields $Q(N) = (a-c)\frac{N}{N+1}$ and $W(N) = \frac{(a-c)^2}{2}\frac{N(N+2\lambda)}{(N+1)^2}$.

If money laundering occurs in a proportion $\zeta \in [0,1]$ of the banks (i.e., ζN banks are errant) it yields an increase in these banks aggregated profit of $\Delta\pi^l(\zeta N)$ increasing with ζN. Assuming they are symmetric each errant bank earns $\frac{\Delta\pi^l(\zeta N)}{\zeta N}$. The criminal activity at the origin of the illicit money generates a world negative externality $M^l(\zeta N)$, increasing in ζN. Indeed the volume of laundered money increase with the number of banks indulging into this activity, increasing their aggregated profits and the total level of externalities. We focus on crimes such that the function $M^l(\zeta N) - \Delta\pi^l(\zeta N)$ is strictly increasing and convex $\forall\zeta \in [\frac{1}{N}, 1]$ with the normalization that $M^l(1) - \Delta\pi^l(1) = 0$. This assumption ensures that the optimization problem is concave. For instance, assuming that each bank can launder an amount $D > 0$ of dirty money then a loss function of the type $M^l(\zeta N) - \Delta\pi^l(\zeta N) = D^{\zeta N} - \zeta ND$ is strictly increasing and convex in $\zeta \in [\frac{1}{N}, 1]$. In other words, the benefit of the banks

that launder illicit money is lower than the global negative externality it creates, and the gap increases with the number of errant banks. In addition to the negative externalities they create outside the banking sector, the errant banks can stall competition by proposing a better deal to their customers than the honest banks, thanks to their undue rents. The AML offence impacts the surplus of the banks' customers by creating an unfair competitive edge. In equilibrium this reduces the number of banks to the level of the errant ones as they are making rents they can use to stall competition. The social surplus becomes: $W^l(\zeta N) = W(\zeta N) + \lambda\Delta\pi^l(\zeta N) - \alpha M^l(\zeta N)$ where $\alpha M^l(\zeta N)$ is the fraction $\alpha \in [0, 1]$ of the total world negative externality $M^l(\zeta N)$ generated by the criminal activity at the origin of the illicit money that is brought into the country. The social loss generated by money laundering for a given $n \in (0, 1]$ is: $L^l(N, \zeta) = W(N) - W(\zeta N) + \alpha M^l(\zeta N) - \lambda\Delta\pi^l(\zeta N)$. We will now consider two relevant polar cases: $\zeta \in \{\frac{1}{N}, 1\}$, although the results are easily generalized to any $\zeta \in [\frac{1}{N}, 1]$.

First, in countries where financial secrecy appears to be an essential element of the private sector's business model (i.e., in tax havens[54]) $n = 1$. This implies that $W(N) - W(\zeta N) = W(N) - W(N) = 0$: When money laundering is not fought at the country level, all the potential banks offer such illicit arrangements and there is no anti-competitive effect on the bank sector of this illegal activity. The social loss generated by money laundering in tax havens is:

$$L^l(N) = \alpha M^l(N) - \lambda\Delta\pi^l(N). \tag{15}$$

The offenders are typically laundering money for crimes committed outside the country's borders. Their society does not suffer directly, at least not more than other countries, from the terrorism, organized crime, or financial criminality that money laundering favors. In other words, in many countries where criminal money is laundered and secrecy is exploited to facilitate tax evasion by foreigners, citizens do not experience the negative externalities of the crime. For the most part, these countries are quiet, affluent, peaceful places.[55] Concretely, this means that for many of the countries where AML offenses happen on a large scale, $\alpha << \frac{\Delta\pi^l(N)}{M^l(N)}$ so that the "loss" $L^l(N)$ from this specific corporate crime is in fact a gain. When α is small (i.e. $\alpha \simeq 0$) then (15) becomes $L^l(N) = -\lambda\Delta\pi^l(N)$ which is negative. In other words, the increase in profit for the banks is larger than the direct negative externality borne by the country hosting them. It is therefore not surprising that tax havens are not doing much to fight money laundering, as this specific crime generates a positive dividend for them. This is a typical free-riding problem insofar as the loss is spread across several jurisdictions while the benefit accrues to one country. It implies that unless there is a coordinated international intervention to fight money laundering, with

[54] An economy that functions primarily as a financial secrecy provider.

[55] According to the International Monetary Fund, the eight major pass-through economies are the Netherlands, Luxembourg, Hong Kong SAR, the British Virgin Islands, Bermuda, the Cayman Islands, Ireland, and Singapore. They host more than 85 percent of the world's investment in special-purpose entities, which are often set up for tax reasons (see Damgaard et al., 2018; countries listed in the order as presented in the report).

economic sanctions large enough to make it socially unprofitable in tax havens, it will continue unabated.

The second interesting polar case is when money laundering is not condoned by the government, and therefore, few firms offer such illicit arrangements. This will typically be the case if the crime plays out domestically. For example, if a German bank assists its rich clients in a scheme for evading German taxes or helps German criminals launder their criminal proceeds, the country bears the whole cost of the criminal activity. Hence, $\alpha = 1$, and in this case the government will fully internalize the cost of this crime (e.g., domestic tax evasion). When few banks are errant in this way the competitive impact of money laundering is large. For instance when $n = \frac{1}{N}$ the social loss becomes:

$$L^l(N) = W(N) - W(1) + \alpha M^l(1) - \lambda \Delta \pi^l(1). \tag{16}$$

In this case, the government will have an incentive to fight the illegal practices, unless it is captured by the corporate sector (i.e., unless λ is very large).

Proof of Proposition 1

Note first that under our assumptions $\tau(1)L(1) = 0$ and $\lim_{N\to+\infty} \tau(N)L(N) = 0$. Moreover, $\left(\tau(N)L(N)\right)' = \tau'(N)L(N) + \tau(N)L'(N)$ so that $\left(\tau(N)L(N)\right)' \geq 0$ if and only if $\frac{L'(N)}{L(N)} \geq \frac{-\tau'(N)}{\tau(N)}$. It can now be confirmed that under our assumptions the LHS of the inequality is decreasing in N (because $L(N)$ is concave), while the RHS is increasing in N (because τ is log-concave). Now we have $\left(\tau(N)L(N)\right)'_{|N=1} = \tau(1)L'(1) > 0$ and $\lim_{N\to+\infty} \left(\tau(N)L(N)\right)' = \overline{L} \lim_{N\to+\infty} \tau'(N) < 0$. This implies that the decreasing function $\frac{L'(N)}{L(N)}$ and the increasing function $\frac{-\tau'(N)}{\tau(N)}$ cross once and only once at $N^* > 1$ defined so that $\frac{L'(N)}{L(N)} = \frac{-\tau'(N)}{\tau(N)}$.

The collusion example

Deriving Eq. (3)

We focus on the possibility that firms might collude to raise price and industry profit. To ease the exposition we consider a linear demand, $Q = a - p$, and $N > 2$ symmetric firms. When they are not colluding, the firms, which face the same marginal cost $c > 0$, compete in Cournot fashion. Since the firms are symmetric we focus on symmetric equilibrium. With a linear demand $P(Q) = a - Q$, each firm produces a quantity $q = \frac{a-c}{N+1}$ so that the total production in the absence of collusion is $Q(N) = (a-c)\frac{N}{N+1}$. The linear assumption is only made to ease the exposition; it is not crucial for the results. The total quantity varies between the monopoly quantity $Q(1) = \frac{a-c}{2}$ when $N = 1$ and the perfect competition quantity $\lim_{N\to+\infty} Q(N) = a - c = Q^*$ when $N \to +\infty$. Accordingly, when $N = 1$ the price is

equal to the monopoly price $p^m = \frac{a+c}{2}$ and it converges toward the perfect competition price $p^* = c$ when $N \to +\infty$. The total corporate profit of the sector is $\pi(N) = \sum_{i=1}^{N} \pi_i(N) = \left[P\big(Q(N)\big) - c\right]Q(N) = N\left(\frac{a-c}{N+1}\right)^2$ and the net consumer surplus is $S(N) = \int_0^Q P(x)dx - P(Q)Q = \frac{Q(N)^2}{2} = \left(\frac{N}{N+1}\right)^2 \frac{(a-c)^2}{2}$. Substituting these values in (1) yields $W(N) = \frac{(a-c)^2}{2}\frac{N(N+2\lambda)}{(N+1)^2}$. We deduce that $L(N) = \frac{(a-c)^2}{2}\left(\frac{N(N+2\lambda)}{(N+1)^2} - \frac{1+2\lambda}{4}\right)$. Rearranging this expression yields (3).

Deriving Eq. (5)

The collusion game in Sect. 3.1 is repeated ad infinitum. The firms common time discount factor is $\delta \in [0, 1]$. The cartel is stable if deviating at any period $t \geq 0$ from the collusive equilibrium is not profitable. We assume that the cartel uses a grim-trigger strategy. This strategy works as follows. Firm $i = 1, \ldots, N$ starts by choosing the action that maximizes cartel profits. It keeps on choosing this action as long as all firms have done so in all previous periods. This corresponds to a cooperation phase.

To capture the fact that the collusive agreement is more risky than the competitive equilibrium, we assume that at each period the collusive profit of the firms is affected by a common random shock ϵ_t IID across period with mean $E\epsilon = 0$. The firm's $i = 1, \ldots, N$ expected profit when it colludes with other firms and nobody deviates from the collusive agreement is:

$$\pi_i^{coll}(N) = \sum_{t=0}^{\infty}\left(\frac{(a-c)^2}{4N}\delta^t + E\epsilon\right)\delta^t = \frac{(a-c)^2}{4N}\frac{1}{1-\delta} \tag{17}$$

The firm $i = 1, \ldots, N$ expected profit when the firms play the competitive outcome is:

$$\pi_i^{comp}(N) = \sum_{t=0}^{\infty}\frac{(a-c)^2}{N+1}\delta^t = \left(\frac{a-c}{N+1}\right)^2\frac{1}{1-\delta} \tag{18}$$

If one firm deviates, deviation "triggers" the start of the punishment phase. Firms choose the action that corresponds to the competitive equilibrium of the static game forever. It implies that if a firm i chooses to deviate it maximizes the instantaneous profit where $Q_{N-i} = \frac{(N-1)(a-c)}{2N}$ is the collusive quantity produced by the other $N-1$ members of the cartel:

$$\max_{q_i} \pi_i\big(q_i, Q_{N-i}\big) = \left[a - \left(q_i + \frac{(N-1)(a-c)}{2N}\right) - c\right]q_i \tag{19}$$

This yield $q_i^{dev} = \frac{N+1}{4N}(a-c)$, which is strictly larger than the collusive quantity. The total quantity produced when firm i deviates and the other firms produce the collusive outcome is $Q^{dev} = \frac{3N-1}{4N}(a-c)$. The instantaneous profit of firm i from this

deviation is $\left(\frac{N+1}{4N}\right)^2(a-c)^2$. The expected profit from deviating from the collusive agreement is:

$$\begin{aligned}\pi_i^{dev}(N) =& \left(\frac{N+1}{4N}\right)^2(a-c)^2 + \sum_{t=1}^{\infty}\frac{(a-c)^2}{N+1}\delta^t \\ =& \left(\frac{N+1}{4N}\right)^2(a-c)^2 + \frac{\delta}{1-\delta}\left(\frac{a-c}{N+1}\right)^2\end{aligned} \tag{20}$$

Comparing (17) and (20) firms do not deviate from the collusive agreement if and only if $\pi_i^{dev}(N) < \pi_i^{coll}(N)$. This yields inequality (5):

$$\delta > \frac{(N+1)^2}{(N+1)^2+4N}.$$

Due to the random shock on firms' collusive profit, at each period collusion breaks down if $\delta \leq \frac{(N+1)^2}{(N+1)^2+4N} - \epsilon^t$. For instance, with a uniform distribution on $[-\delta, \delta]$ with $\delta \geq 0.5$, collusion unravels with probability $Prob\left(\epsilon \leq \frac{(N+1)^2}{(N+1)^2+4N} - \delta\right) = \frac{1}{2\delta}\frac{(N+1)^2}{(N+1)^2+4N}$.

Proof of Proposition 3

The problem is solved backwards as follows: If the firm discovers that a corporate crime has occurred, it can report it to the public authorities in exchange for a reduced fine F^r. It can also hide it from the authorities to avoid a fine. However, if the government finds out about the crime on its own, it might conduct a thorough investigation to learn whether the firm was aware of the problem and covered it up, or not. If it turns out that the firm staged a cover-up, the sanctions could be harsher F^h. It would be F otherwise. This implies that

$$\begin{aligned}E\pi =\ & p^f(m/K)\Big[\mathbb{1}_{\{r\}}(\pi(1)-F^r) \ +\ \mathbb{1}_{\{h\}}(1-p^g(m^g/K))\beta\pi(1) \\ & +p^g(m^g/K)(\beta\pi(1)-F^h))\Big] \\ & +\big(1-p^f(m/K)\big)(1-p^g(m^g/K))\beta\pi(1) \\ & +p^g(m^g/K)\big(1-p^f(m/K)\big)\big(\beta\pi(1)-F\big),\end{aligned}$$

which simplifying yields (6):

$$\begin{aligned}E\pi =& \beta\pi(1) - \big(1-p^f(m/K)\big)\Big(p^g(m^g/K)F\Big) \\ & - p^f(m/K)\Big(\mathbb{1}_{\{r\}}F^r + \mathbb{1}_{\{h\}}p^g(m^g/K)F^h\Big)\end{aligned}$$

The standard Beckerian model of crime deterrence is obtained simply by setting $K = m = 0$ so that $p^f(m/K) = 0$. In this case (6) becomes $E\pi = \beta\pi(1) - p^g(m^g/K)F$. Let $\pi(N)$ be the firm's profit when it behaves honestly. Crime is deterred if and only if $E\pi \leq \pi(N)$, or equivalently:

$$F \geq \frac{\beta\pi(1) - \pi(N)}{p^g(m^g/K)}.$$

Since monitoring is costly for the government, it is optimal to set m^g as close as possible to 0 so that the punishment F goes to infinity (see Becker, 1968). The problem with this Beckerian solution is that it fails to capture limited liability and bankruptcy constraints. Taking into account that in practice the fine is bounded, $F \leq \overline{F}$, the government needs to detect the corporate crime with at least probability $p^g(m^g/K) \geq \frac{\beta\pi(1)-\pi(N)}{\overline{F}} > 0$ with $\beta \in \left(\frac{\pi(N)}{\pi(1)}, 1\right]$. In many cases the government will be unable to meet this deterrence condition, since governments are rather inefficient when it comes to monitoring corporate practices in violation of the law. In other words, crimes will occur in equilibrium and the next issue is how to make sure firms have incentive to monitor and report them.

The firm invests sequentially, first in preventive measures K, and second, in day to day monitoring, m. We solve the problem backwards: Assuming $K > 0$, the optimal level of monitoring m solves: $\max_m\{E\pi - c(m)\}$, where $E\pi$ is defined in (6) and $c(m)$ is the cost of investing in monitoring increasing and convex in m. If condition (8),

$$p^g(m^g/K)F^h > F^r,$$

does not hold, the firms never report a crime, and have no incentive to invest in monitoring $m^* = 0$. If (8) holds, the firm always chooses to cooperate when it discovers a crime: $\mathbb{1}_{\{r\}}$ equals 1 and $\mathbb{1}_{\{h\}}$ equals 0. Substituting these values in (6) and optimizing $E\pi - c(m)$ with respect to m the first order condition (FOC) is $\frac{\partial(E\pi - c(m))}{\partial m} = \frac{\partial p^f(m/K)}{\partial m}\left(p^g(m^g/K)F - F^r\right) - c'(m) \leq 0$. This expression makes it clear that a firm has no incentive to invest in monitoring if $p^g(m^g/K) = 0$. When $m^g = 0$, (6) becomes $E\pi = \beta\pi(1) - p^f(m/K)\mathbb{1}_{\{r\}}F^r$, which is decreasing both in m and K: at the optimum the firm chooses $m^* = 0$ and never reports any crime. If the government wants the firms to invest in monitoring, sanctions must be set so that (8) holds, in which case there is an interior solution $m^* > 0$ solution to (9):

$$\frac{\partial p^f(m/K)}{\partial m}\left(p^g(m^g/K)F - F^r\right) = c'(m).$$

Under our assumptions the problem is concave so that the FOC is sufficient. Total differentiating $m^* > 0$ with respect to m^g in (9) and collecting the preceding results yield Proposition 3.

Proof of Proposition 5

Consider the sanctions of corollary 1, $F^r = 0$ and $F = F^h = \overline{F}$, so that the self-reporting corporation profits from a stronger market position after reporting the crime, as its competitors are weakened by the sanction. To be more specific, the

instantaneous profit of the $N-1$ competitors of a firm cooperating with law enforcement agencies is $\frac{\pi(1)}{N}-\overline{F}$, which in general is negative, as ring-leaders are typically excluded from leniency programs with the aim of avoiding strategic use of the system.

Assuming the firms face a random shock in their operations affecting their financial viability, ξ^i independently and identically distributed in $[0,+\infty)$, the firms go bankrupt if $\xi^i \leq F^i$. We deduce that the $N-1$ firms competitors of the self-reporting firm fined at $\overline{F}$ go bankrupt if $\xi^i \leq \overline{F}$. Let the density of ξ^i be $g(\xi)$ and the c.d.f $G(\xi)$. The proportion of firms impacted by the penalty that goes bankrupt is: $Prob\left(\xi^i \leq \overline{F}\right) = G(\overline{F}) > 0$. By contrast the firm that benefits from the leniency program has a fine of 0 and therefore does not go bankrupt. As a result there are in expectation $EN^c = 1+(N-1)(1-G\left(\overline{F}\right)) \leq N$ firms left to serve the market.

We have considered a static problem for the sake of simplicity. However as shown in appendix results can be easily generalized to an infinite horizon dynamic setting. It shows that collusion is an equilibrium when (5) holds. Since ϵ_t is IID accross period, there is a probability that at each period (5) is violated and the collusion collapses. If a leniency program is in place, firms will rush to the competition authority to be the first to report the collusion agreement and benefit from leniency. When $F^r = 0$ the expected profit of the first self-reporting firm is $\frac{\pi(1)}{N}+\delta\frac{E\pi(N^c)}{1-\delta}$, where $\delta < 1$ is the discount factor of future profits. For its competitors, when $F = F^h = \overline{F}$, the expected profit is $\frac{\pi(1)}{N}-\overline{F}+(1-G(\overline{F}))\delta\frac{E\pi(N^c)}{1-\delta}$.

Comparative statics

Let τ_x denotes the partial derivative of the function τ with respect to the variable x, and $\tau_{x,y}$ denotes the cross-derivative of the function τ with respect to the variable x and y.

Sign of $\frac{dK^*}{dQ} > 0$

Since $L(N)$ increases with the size of the market Q^*, as illustrated for instance by (3), (12) implies that precautionary measures should be larger in larger markets:

$$\frac{dK^*}{dQ} = \frac{-\tau_K(N/K)\frac{\partial L(N)}{\partial Q}}{\tau_{KK}(N/K)L(N)} > 0. \tag{21}$$

Sign of $\frac{dK^*}{dN}$

By contrast, the impact of the sector concentration, as measured by N, on the optimal level of precautionary measures is ambiguous. Totally differentiating (12) with respect to N yields:

$$\frac{dK^*}{dN} = \frac{\Big(- \tau_{NK}(N/K)L(N) - \tau_K(N/K)L'(N)\Big) - 1}{\tau_{KK}(N/K)L(N)}. \tag{22}$$

Since $\tau(N/K)$, is decreasing and convex in K, the denominator is positive, while the numerator sign is ambiguous. On the one hand, when N is larger, precautionary measures are socially more costly as each firm needs to pay K. This cost effect decreases the optimal level of K as captured by -1 in the numerator. On the other hand, assuming the cross-derivative of τ with respect to N and K is negative, $\tau_{NK}(N/K) = \frac{\partial^2 \tau}{\partial N \partial K} \leq 0$, the numerator term in the parenthesis is positive: the marginal benefit of preventive measures K on the expected social loss $\tau(N/K)L(N)$ increases with N the number of firms active in the sector, pushing up the optimal level of K. Depending on how the value of the term in bracket compares to 1, the optimal level of precautionary measures might increase or decrease with N. However if the elasticity of the loss function with respect to N, $\epsilon_{L,N} = \frac{L'(N)N}{L(N)}$, is greater than 1, using the first order condition (12) implies $-\tau_K(N/K)L'(N) - 1 = \frac{L'(N)N}{L(N)} - 1 > 0 \frac{L'(N)N}{L(N)} - 1 > 0$ so that $\frac{dK^*}{dN} > 0$. In this case the positive effect outweighs the direct cost effect, and precautionary measures should (locally) increase with N. In the collusion example (3), the elasticity of the loss function depends on N. It is greater than 1 for the low value of N (e.g., for $N = 2$) and lower than 1 for large value of N. Accordingly, when the market is relatively concentrated, precautionary measures should increase with N.

Sign of $\frac{dN^*}{dK}$

Finally, and importantly, we ask whether precautionary measures are useful to control corporate crimes. To answer, we need to study how N^* defined in Proposition 1 varies with K. Totally differentiating N^*, solution to $L(N)\tau_N(N/K) + L'(N)\tau(N/K) = 0$ in (4) yields:

$$\frac{dN^*}{dK} = \frac{-L'(N)\tau_K(N/K) - L(N)\tau_{NK}(N/K)}{\tau_{NN}(N/K)L(N) + 2L'(N)\tau_N(N/K) + L''(N)\tau(N/K)}. \tag{23}$$

Under our assumptions the denominator (SOC of the optimization problem of N^*) is always negative, while the numerator is positive when the cross-derivative of τ with respect to N and K is negative. In other words, $\frac{dN^*}{dK} < 0$ for all $K \geq 0$ and N^* defined in Proposition 1 when $\frac{\partial^2 \tau}{\partial N \partial K} \leq 0$. The expected loss function is decreasing in K so that increasing preventive measures decreases the critical number of firms that maximizes the social loss of stalling competition. Minimizing social loss by imposing preventive measures of level $K^* \geq 0$ defined in (12) on firms, decreases their ability to commit a corporate crime that will go undetected. In other words, *imposing preventive measures K^* solution to (12) limits the number of firms that can conspire without being detected, and therefore, the extent of corporate crimes.*

Methodology for computing the indexes in Table 1

In Table 1 the closer to 1 the more consistent the regulation is with a focus on consumer surplus (fair competition in markets); the closer to 5 the easier it is for firms to profit from the listed forms of crime (even if detected and sanctioned). The classifications are based on a combination of information from available sources and our own direct collection efforts:

- The contents of the law in question for each country: corruption/bribery, anti-money laundering, and competition law.
- Information about enforcement practices found on the websites of the respective law enforcement agencies.
- Our research assistant's ability to find the information in question in other official websites when searching for information about cases and enforcement practices.
- Our research assistant's ability to obtain the information when approaching the enforcement agencies in question, by help of email requests and phone calls.

Based on this effort of information collection we build two indices.

Facts about the corporate offence: It assesses whether facts are available for researchers, and presented in a manner that makes it possible to assess the proportionality between penalty and corporate misconduct (De facto discretion with respect to charge). The ranking is as follow:

1. Wrongdoing comprehensively defined with respect to negligence (guilt) and sanction calculated in accordance to case law or directives. Information available.
2. Wrongdoing described (and information made available for researchers). Assessment of wrongdoing and implication for sanctions briefly described.
3. Information about wrongdoing available but too incomplete (or unclear legal basis) for researchers to understand the logic behind the calculation of sanctions.
4. Sanctionable conduct unclearly described. Information about the facts hard to obtain (researchers must apply for access or other comprehensive process)
5. Sanctionable conduct is not well defined. Information about the facts of the case not available for researchers. Calculation of sanctions unclear.

Predictable leniency: It assesses the clarity in regulations regarding reduced penalty for corporate offenders' self-reporting of suspected offences and cooperation with law enforcement agencies. 'Clarity' includes explicit instructions of what self-reporting and cooperation means (Which acts apply, what reduction is to be expected).

1. Clear regulations and predictable practice for sanction reductions on well-specified acts of self-reporting and cooperation.
2. Sanction reductions expected upon well-specified acts of self-reporting and cooperation. Strictly applied.

Table 5 Summarizing the case material

Violation	Case	Industry/market	Market	Penalty	Deterrence	Location
United Kingdom						
Competition	British Airways (2012)	Air transport	Concentrated	EUR 65.6 million	No	Uncertain
Competition	Galvanised steel tanks (2016)	Water storage local market	d.m	d.m		Home
AML	Standard Bank (2014)	Banking industry global market	Concentrated	EUR 8.52 million		Abroad
AML	Deutsche Bank (2017)	Banking industry global market	Concentrated	EUR 182.7 million	Yes	Abroad
AML	Standard Chartered Bank (2019)	Banking industry global market	Concentrated	EUR 114.6 million	d.m	Abroad
Corruption	Standard Bank (2015)	Banking industry global market	Concentrated	EUR 29.6 million	Yes	Abroad
Corruption	Rolls Royce case (2017)	Aerospace industry, energy industry	Concentrated	EUR 752.1 million	No	Abroad
Corruption	Smith & Ouzman Ltd. (2014)	Security printing market	Competitive	EUR 2.5 million	Yes	Abroad
Corruption	XYZ/Sarclad case (2016)	Technology for steel production	Concentrated	EUR 7.3 million	No	Abroad
Competition	Beer price fixing (2015-2016)	Beer production	d.m	EUR 112 million (11/11)		Home
Germany						
Competition	Candy price fixing (2015)	Candy retail	Concentrated	EUR 60 million (7/7)	d.m	Home
Competition	Asphalt manufacture price fixing (2018)	Asphalt manufacturing	d.m		No	Home
Competition	SodaStream abuse of dominant position (2015)	Soda maker market	d.m	EUR 225,000	d.m	Home
Competition	ZEG bicycle wholesaler (2018)	Bicycle wholesale	Concentrated	EUR 13.4 million	d.m	Home
Corruption	Siemens resolution (2008)	Electronics and appliances	Competitive	EUR 1.45 billion	No	Abroad
Corruption	Airbus Defence and Space GmbH (2018)	Aerospace industry	Concentrated	EUR 81 million	No	Abroad
Corruption	MAN Ferrostaal (2011)	Oil and gas plant construction	d.m	EUR 10 million	No	Abroad
Corruption	DB Schenker (2016)	Logistics market	Competitive	EUR 2 million	No	Abroad
Corruption	No identity Case Bav 2011/2	Industrial/unknown	d.m	EUR 35 million	d.m	Abroad
Corruption	Atlas Elektronik (2017)	Arms production	d.m	EUR 48 million	d.m	Abroad

Table 5 (continued)

Violation	Case	Industry/market	Market	Penalty	Deterrence	Location
The Netherlands						
Competition	Concrete cartel case (2015)	Concrete garage manufacturing	Concentrated	EUR 306,500 (1/2)	d.m	Home
Competition	Vinegar cartel (2015)	Natural vinegar manufacturing	d.m	EUR 1.8 million (1/2)	d.m	Home
Competition	Dutch Railways NS (2017)	Railway operations	Concentrated	EUR 40.95 million (+ contract lost)	d.m	Home
Competition	Forklift truck batteries	Forklift truck battery import	Concentrated	EUR 17.5 million (7/7)	d.m	Home
AML	ING Groep NV (2018)	Banking industry	Concentrated	EUR 775 million	No	Abroad
AML	No identity (2018)	Banking industry	d.m	EUR 40,000	d.m	Uncertain
Corruption	Ballast Nedam case (2012)	Construction and engineering	Competitive	EUR 17.5 million	No	Abroad
Corruption	Telia case (2017)	Telecom market	Concentrated	EUR 274 million	No	Abroad
Corruption	VimpelCom case (2016)	Telecom market	Concentrated	EUR 397.5 million	No	Abroad
Corruption	SBM Offshore case (2014)	Offshore oil drilling equipment	Competitive	EUR 217.8 million	No	Abroad
Sweden						
Competition	Svenska Förpacknings- och Tidningsinsamlingen AB (2018)	Waste management	Competitive	EUR 1.9 million	Yes	Home
Competition	Ragn-Sells AB and Bilfrakt Bothnia AB (2016)	Waste management	Concentrated	EUR 0.43 million (2/2)	Yes	Home
Competition	Däckia/Euromaster (2014)	Tires and tire service	d.m	EUR 0.24 million (2/2)	d.m	Home
Competition	TeliaSonera case (2013)	Telecom market	Concentrated	EUR 3.4 million	Yes	Home
Competition	Scandorama AB and Ölvemarks Holiday AB (2012)	Tourism	d.m	EUR 1.06 million (2/2)	d.m	Home
Competition	Asphalt cartel (2009)	Asphalt paving	Concentrated	EUR 26.6 million (5/5)	d.m	Home
AML	Nordea decision (2015)	Banking industry	Concentrated	EUR 4.8 million	d.m	d.m
AML	Handelsbanken decision (2015)	Banking industry	Concentrated	EUR 3.3 million	d.m	d.m
Corruption	Bravur and Dynamic Sailing (2016)	Construction industry Sailboat manufacturing	NA	EUR 0.3 million (2/2)	d.m	Home

Table 5 (continued)

Violation	Case	Industry/market	Market	Penalty	Deterrence	Location
Corruption	KEWB (2018)	Street maintenance	NA	EUR 28,836	d.m	Home
Norway						
Competition	Gran & Ekran (2012)	Contracting industry	d.m	EUR 0.2 million	d.m	Home
Competition	Telenor case (2018)	Telecom market	Concentrated	EUR 73 million	d.m	Home
Competition	El-proffen case (2017)	Electrical services	d.m	EUR 0.1 million (6/6)	d.m	Home
AML	Santander (2019)	Banking industry	Concentrated	EUR 0.8 million	Yes	d.m
AML	DNB case (2019)	Real estate market (commercial)	Concentrated	EUR 27,783	No	d.m
AML	Koppang Landbruks- og Nærings-megling AS (2019)	Real estate market (agricultural)	Concentrated	EUR 18,522	No	Home
AML	Sædberg & Hodne AS (2019)	Real estate market (commercial)	Competitive	EUR 18,522	No	Home
Corruption	Peab/Vannverk-saken (2008)	Construction industry	Competitive	EUR 0.3 million	d.m	Home
Corruption	Yara (2014)	Fertilizer	Concentrated	EUR 27.3 million	No	Abroad
Corruption	Store Norske (2011)	Shipping	Concentrated	EUR 0.4 million	d.m	Abroad

Table 6 The Case material

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Great Britain cases					
Competition	Airline price fixing (2012)	Airtransport Global market	CR = 0,16 Lerner BA = 0,15 Lerner VAA = -0,035 Combined market shares in relevant market: 78% (narrow definition of market)	BA: £58,5 mill. Reduced from £121,5 mill (liniency policy + "Exeptional additional procedural cooperation") VAA: No penalty	Surcharge rose from £5 to £30. 35 634 000 passengers carried in 2005. Long haul unknown. Approximate gain: £29 mill. Assuming Becker, this means 0,49 prob of detection. Penalty too low
Competition	Galvanised Steel Tanks cartel infringement (2016)	Water Storage Local Market	No specific company	Facts not found	
Laundering	Standard Bank (2014)	Banking Industry Global Market	CR = 0,27 Lerner = 0,44 Average Lerner in market = 0,1 HHI = 1800 CR4 business current accounts = 0,85 CR4 business loans = 0,9 CR4 personal current accounts = 0,7 Entry barriers	£7,6 mill. Reduced 30% from £10,9 mill (early settlement)	Relevant revenue in period: £50 mill. Pre mitigation/aggrivation fine: 15% of revenue =£7,5 mill. If this is estimated gain: Fine too low. Average AML spending Europe: £16,55 mill. Impossible to know SB's cost reduction. If 15%: £2,5 mill. Appropriate fine
Laundering	Deutche Bank (2017)	Banking Industry Global Market	CR = 0,27 Lerner = 0,068	£163 mill (£9,1 mill disogorgement). Reduced 30% from £229 mill (early settlement)	Commision from suspicious trading: £9,1 mill (disogorgement). No adjustment for deterrance (fine considered sufficient). Lack of recources to AML and IT systems. Impossible to know DB's cost reduction, but fine seems sufficient/high

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Laundering	Standard Chartered Bank (2019)	Banking Industry Global Market	CR = 0,27 Lerner = 0,212	£102,2 mill. Reduced 30% from £145,9 mill (early settlement)	No identified direct financial benefit. (Actually no benefit or not possible to determine?) No adjustment for deterrance (fine considered sufficient). Insufficient recources in Financial Crime Risk function. Impossible to know cost reduction or determine high/low penalty
Corruption	Standard Bank (2015)	Banking Industry Global Market	CR = 0,27 Lerner = 0,44 (Vurdere ny for 2015) Average Lerner in market = 0,1 HHI = 1500	Compensation to Tanzania: $7 mill. Disgorgement: $8,4 mill. Financial penalty: $16,8 mill	Gain: $8,4 mill - $6 mill bribe. According to Becker model: 0,07 Probability of detection. Sufficient/high fine
Corruption	The Rolls Royce-case (2017)	Aerospace Industry Energy Industry	Lerner = 0,02 Concentrated industry. Top 20 companies make up 73% of the market. Top 3 companies make up 41% of the market	Disgorgement: £258,2 mill. Financial penalty: £239,1 mill. Cost of investigation: £13 mill	Total amount of bribe payments unknown. Profit gained: £258,2 mill. According to Becker model: 0,5 probability of detection. Penalty too low
Corruption	Smith and Ouzman ltd. (2014)	Security Printing Market	Lerner = 0,03	Confiscation order: £881 158. Fine: £1,3 mill. Costs: £25 000	Corrupt payments: £395 074. Not clear if bribes are subtracted from confiscation order. If yes: 0,4 probability of detection; Penalty too low. If no: 0,2 probability of detection; Sufficient penalty

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Corruption	XYZ-case/Sarclad Ltd. (2016)	Technology for steel production	Lerner = 0,38	Disgorgement: £6,2 mill. Financial penalty: £352 000. Repayment of dividends from US parent company: £1,9 mill	Disgorgement equal to gross profit from contracts. Penalty too low, both including and excluding parent company (0,7 prob of detection)
Germany cases					
Competition	Beer price fixing (2015-2016)	Beer Production	Lerner NA (no company specified) CR5 global 2018: 0,02 CR4 national 2005: 0,49	Total fines on 11 companies: €112 mill. Two companies were not fined due to collaboration. Decision made by Bundeskartellamt, not offered leniency. All but two companies got 10% reduction for settling. Type, gravity and duration taken into account	Difficult to say. Sanction not explained by the logic of Becker style reasoning
Competition	Candy price fixing (2015)	Candy Retail	Lerner Aldi Lerner Lidl German food retail is highly concentrated. Aldi and Lidl are the largest in the market. CR4 2018: 0,92 (Check that this is correct and not only discounters) Haribo largest supplier by far	Total fines on 7 companies: €60 mill. Potential gain and harm was considered in calculation of fines. Aldi and Lidl favoured because price maintenance affected smaller range of products. Haribo's fine based exclusively on company's total turnover. For Haribo and Rewe, cooperation was mitigating factor	Difficult to say. Potential gain and harm was taken into consideration. Biggest retailers got reductions. Biggest supplier in the market also got reduction
Competition	Asphalt manifacture price fixing (2018)	Asphalt Manifacturing	Lerner NA (can't find financial statement)		

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Competition	SodaStream abuse of dominant position (2015)	Soda Maker Market	Lerner NA (can't find financial statement) Market share 2017: 0,90-1		
Competition	ZEG/Bicycle wholesaler (2018)	Bicycle Wholesale	Lerner = 0,29	Total €13,4 mill. Cooperation taken into account. Reduction unknown	Impossible to say.
Corruption	The Siemens-resolution (2008)	Electronics and appliances	Lerner = 0,12 Market share national: 0,17 CR4 national: 0,47 Market share global: 0,08 CR4 global: 0,32	Total fine to German and US government: $1,6 billion. US: $350 mill disgorgement, $448,5 mill fine. Germany: €394,75 mill disgorgement, €250 000. Cooperation and penalty by other country taken into account. Reduction unknown	In Germany alone: disgorgement almost full amount of fine. Collective: 0,49 prob of detection. Still too low penalty
Corruption	Airbus Defence and Space GmbH (2018)	Aerospace Industry	Lerner =0,08 Concentrated industry. Top 20 companies make up 73% of the market. Top 3 companies make up 41% of the market. Airbus is one of top 3	Confiscatory component: €81 mill. Punitive component: €250 000	Confiscatory component amounts to almost full amount. Small deterring effect. Penalty too low
Corruption	MAN/Ferrostaal (2011)	Oil and gas plant construction	Lerner = 0,10	Confiscatory component: €9,5 mill. Punitive component: €500 000	Too low penalty

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Corruption	DB Schenker (2016)	Logistics Market	Lerner = 0,03	Confiscatory component: €1,7 mill. Punitive component: €300 000	Bribes payed amounted to €1,7 mill. Confiscatory component equal to amount of bribe payments because the proceeds of bribery could not be estimated. Basic economic theory, assuming rationality: proceeds > bribes. No deterring effect. Penalty too low
Corruption	Case Bav 2011/2 (2011)	Unknown/ Industrial plant prod	Lerner NA (unknown company)		
Corruption	Atlas Electronik (2017)	Arms production	Lerner NA (can't find financial statement)		
	Netherland Cases:				
Competition	Concrete cartel-case (2015)	Concrete Garage Manifacturing	Lerner NA (can't find financial statement)		
Competition	Natural-vinegar manifacturers cartel (2015)	Natural-vinegar Manifucturing	Lerner NA (can't find financial statement)		
Competition	Dutch Railways NS (2017)	Railway Operation	Lerner = 0,03 CR4 = 1 (only 4 companies)	€40,95 mill fine. Loss of contract.	Submitted bid that outweighed the revenues. Pilot project for several operators on same tracks. Gain would come from securing contract alone, to prevent competition in the future. Impossible to tell how much gain. Combined with loss of contract, sufficient/ high penalty

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Competition	Forklift Truck Batteries	Forklift Truck Battery Import	Lerner Midac = 0,70 Lerner Era NA (can't find financial statement	Midac: fined €583 000. Era: fined €450 000. Total all companies: €17,5 mill	Impossible to tell.
Laundering	ING (2018)	Banking Industry	CR = 0,27 CR4 = 0,87 Lerner = 0,37	€675 mill fine + €100 mill disgorgement	Not possible to determine total amount of illegal transactions. Disgorgement represents under-spending in compliance/AML. Disgorgement does not reflect commission from transactions. If gain actually was €100 mill: 0,13 prob of detection → Sufficient penalty. Gain is likely more than €100 mill. In that case, penalty likely too low
Laundering	A present of 8 mill Euros (2018)	Unknown/ Banking Industry	CR = NA/0,27		
Corruption	The Ballast Nedam-case (2012)	Construction and Engineering	Lerner = -0,02 CR4 = 0,24	Fine: €5 mill. Waived tax claim against government: €12,5 mill. Total: €17,5 mill	Parent company secured €45 billion contract by paying €1 billion kickbacks. More than half of the payments made by BN. Gain for BN unknown. If half of parent company gain: penalty too low. Basic economic theory, assuming rationality: Gain > 500 mill → Penalty too low

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Corruption	The Telia-case (2017)	Telecom Market	Lerner = 0,25 CR3 broadband = 0,52 - 0,57	Criminal fine: $100 mill. Confiscation: $174 mill. Disgorgement: $208,5 mill. Cooperation credited. Reduction unknown	Assuming disgorgement correctly represent gain: 0,43 prob of detection. Penalty likely too low for deterrance
Corruption	The VimpelCom-case (2016)	Telecom Market	Lerner = 0,16 CR3 broadband = 0,52-0,57	Fine: $100 mill. Confiscation: $130 mill. Subsidiary confiscation: $167,5 mill. Civil proceding disgorgement: $187,5 mill. Cooperation taken into consideration	Confiscation and disgorgement make up a significant part of total penalty. If this is a correct estimate of gain: penalty too low
Corruption	SBM Offshore-case (2014)	Offshore oil drilling equipment	Lerner = 0,06	Fine: $40 mill. Disgorgement: $200 mill. Cooperation taken into consideration	Estimated profits from contracts: 2.8 billion. Penalty not big enough for deterrance. Disgorgement seems to amount to bribe payments made. Even if this was the criminal gain, the penalty would be too low
Corruption	The Klimop-case (2012)	Real Estate Market	NA (not enough info on case)		
	Sweden Cases				
Competition	Svenska Forpacknings-och Tidningsinsamlingen AB (2018)	Waste Management	Lerner = 0 (?) CR5 private companies = 0,28 CR5 public companies = 0,26 Monopoly	Fine: 20 mill kronor. Defined as serious breach	The fine was set with a view to deterrence. Impossible to say how big the gain was. Possibly sufficient penalty

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Competition	Ragn-Sells AB and Bilfrakt Bothnia AB (2016)	Waste Management	Lerner RS = 0,04 Lerner BB = CR5 private companies = 0,28 CR5 public companies = 0,26	Fee (harm of competition), RS: 2,45 mill kronor. 100% upward adjustment for initiating offence. Fee harm of competition, BB: 2,06 million SEK. Adjusted neiter up or down	Difficult to tell how much gain from illegal agreements. RS profit in 2013 in relevant market: 5,570 mill. Base for fine 5% of profit = 278 500. If this is equivalent to gain, penalty is sufficient /high. BB base for fine: 588 800
Competition	Dockia/Euromaster (2014)	Tyre and Tyre Service	Lerner NA (can't find financial statement)		
Competition	Telia Sonera-case (2013)	Telecom Market	Lerner = 0,24 CR = 0,81 Market share: 38,8%	Fine: 35 mill SEK.	Accused of margin squeezing. Gain of limiting competition has to be bigger than cost of low/negative margin. No evidence that the competition limitation could be economically motivated. If that is the case: no/low gain; Penalty sufficient/high
Competition	Scandorama AB and Ölvemarks Holiday AB (2012)	Coach Operation	Lerner NA (can't find financial statement)		
Competition	Asphalt Cartel (2009)	Asphalt Paving	Lerner NA (companies not specified)		
Laundering	Nordea-decision (2015)	Banking Industry	CR = 0,27 CR4 credit market = 0,7 Lerner = 0,46 One analyses concludes with no evidence of lack of competition	Fine: 50 mill SEK. No extenuating circumstances. No reduction	Gain is sum of commissions from illegal transactions and cost reduction of not having satisfying AML control. Impossible to say how high gain. (Can look at financial statements)

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Laundering	Handelsbanken-decision (2015)	Banking Industry	CR = 0,27 CR4 credit market = 0,7 Lerner = 0,51 One analyses concludes with no evidence of lack of competition	Fine: 35 mill SEK. No extenuating circumstances. No reduction	Gain is sum of commissions from illegal transactions and cost reduction of not having satisfying AML control. Impossible to say how high gain (could look at financial statements)
Laundering	Södertörns Tingsrätt criminal case (2017)	Unknown	Lerner NA		
Corruption	Kriminalvardenfallet (2016)	Unknown	Lerner NA		
Corruption	Sponsringsfallet (2016)	Construction Industry Sailboat Manufacturing	NA	Impossible to say.	
Corruption	The Telia-case (2019)	Telecom Market	Lerner = 0,16 Market share: 36,1% CR: 0,79	Telia is not subject to forfeiture in Sweden. Disgorgement of 208,5 mill has been payed to the Netherlands	See Netherland's case against Telia.
Corruption	Underprisfallet (2018)	Street Maintanance	NA	Impossible to say.	
	Norway Cases:				
Competition	Gran og Ekran (2012)	Contracting Industry	Lerner NA (can't find financial statement)	Fine: 2 mill NOK	Grunnarbeid would have had 7 mill NOK in profits from the contract. Gran & Ekran's gain is unclear. Impossible to say if fine is sufficient
Competition	The Tine-case (2009)	Dairy Production	Lerner = 0,06 Market share of 76,3% on white cheese and 90% on brown cheese	Aquitted in Supreme Court	Not relevant

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Competition	The Telenor-case (2018)	Telecom Market	Lerner = 0,38 Only two companies have their own network. High degree of market concentration. Market share mobile revenue: 56% Market share broadband revenue: 37% CR mobile revenue: 97% CR broadband revenue: 60% HHI = 4000	Fine: 788 mill NOK	Impossible to tell. (Can check financial statements)
Competition	The El-proffen case (2017)	Electrical Services	Lerner = 0,1 6 companies involved, only one specified	All 6 companies fined, ranging from 1,29 mill NOK to 2,5 mill NOK	Impossible to tell. Can dig more to find all companies
Laundering	Santander (2019)	Banking Industry	Global CR = 0,27 Local CR = 0,5 Lerner = 0,42	Fine: 9 mill NOK. Self-reporting and cooperation is noted	Deterrent effect of sanction considered. None of the transactions turned out to be illegal → no direct gain. Gain from cost reduction of not having sufficient control systems. Impossible to tell how big gain. Penalty likely sufficient. (Can check financial statements)

Table 6 (continued)

Violation	Case	Industry/market	Market concentration	Penalty	Profit from Crime
Laundering	The DNB-case (2019)	Real Estate Market (commercial)	Lerner = 0,56	Fine: 300 000 NOK	Gain from cost reduction of not having sufficient AML-systems. Impossible to tell how big gain, but fine seems too small to make up for gain and deterrence. (Can check financial statements)
Laundering	Koppang-Landbruk og Næringsmegling AS (2019)	Real Estate Market (agricultural)	Lerner = 0,23	Fine: 200 000 NOK	Gain from cost reduction of not having sufficient AML-systems. Impossible to tell how big gain, but fine seems too low to make up for gain and deterrence. (Can check financial statements)
Laundering	Næringsmegleren Sædberg & Hodne AS (2019)	Real Estate Market (commercial)	Lerner = 0,16	Fine: 200 000 NOK	Gain from cost reduction of not having sufficient AML-systems. Impossible to tell how big gain, but fine seems too small to make up for gain and deterrance. (Can check financial statements)
Corruption	Norconsult (2013)	Consulting Market	Lerner = 0,09	Aquitted because of other sanctions (suspension from World Bank tenders, possibly suspension from all public tenders)	Gain from contract: 15,9 mill NOK. Deprived of contracts worth 275 mill NOK due to World Bank suspension. Other sanctions sufficient for deterrence
Corruption	PEAB/Vannverk-case (2008)	Construction Industry	Lerner = 0,04	Fine: 3 mill NOK. Aggravating factor: PEAB AS penalized for similar offences earlier. Extenuating factors: Coopera-tion and long time passed	Deterrence taken into account. Gain from undertakings given to PEAB AS without competition, and liquidity gain from payments up front. Impossible to say how big gain

3. Sanction reductions described as a result of self-reporting and cooperation yet unclear what acts lead to what degree of penalty reduction. Generously applied for corporate offender.
4. Sanctions reduced upon confession of crime yet no explicit rules for cases of corporate crime, and the benefits of cooperation are unclear yet often excessive
5. The calculation of sanctions in cases of corporate misconduct is unclear and unpredictable. Harldy any information available.

Case material

Table 5 presents an overview of the cases considered for this research. All three categories of offenses are listed for all countries in the study, apart from Germany, where facts about AML cases could not be retrieved. Each case is listed with the name of the offender (if the perpetrator's identity is known) or commonly used keywords, plus the year, industry, market concentration (as estimated), the penalty, whether the penalty might deter crime or not, and whether the harms from the crime were felt in the corporation's home country or abroad. The listed penalty includes the total agreed amount reached through trial or settlement, including fine payment, disgorgement, asset recovery, and in some cases compensation. The amount does not include additional fine payments to other countries, such as the United States, which are relevant in several of the cases. The parentheses (m/n) in the penalty column indicate total penalty for m out of n corporate offenders involved. The letters d.m. stands for 'details missing'.

Theoretically, the penalty should reflect the gain from crime. In enforcement cases, however, the exact gain is rarely calculated because prosecutors must prove the connection between the crime and the profit (in corporate crime cases they can prove only some of it). The indicators available in some cases, when the size of the penalty is known, is the accusation (i.e., a firm allegedly profited...) or in terms of confiscations made as a part of the enforcement action (i.e., in addition to the penalty, EUR X is confiscated). As described in the paper and in more detail in Table 6, it was a major difficulty to obtain facts about the 50 cases considered for the study, many of them settlement-based enforcement. For 24 of them we got reliable facts about the corporate penalty, and for most, the case materials refer to some estimated gain from the offence (either as part of the accusation or in terms of confiscations, either presented as a press release /public information). In terms of being estimates, such figures are very conservative, as the true criminal proceedings may well be larger. Given the official estimates of the gain from crime (even if conservative), we had two out of three uncertain variables for our evaluation of whether a penalty was 'high' or 'low'. We did not have the detection rate. However, as described in the paper, we classified the cases for which the penalty and some estimated gain were available, using the assumption that any detection rate above 25 percent is unrealistic.

Considering information from the case review in Table 6, we found seven cases could have a penalty high enough to deter future crime, i.e., the penalty was not obviously too low. In the other cases, we can say for certain that the

penalty was too low to have a deterrent effect on future crime. The evaluation takes into account what we know about leniency, and the cases when leniency is offered (no or very low penalty) are considered consistent with the theory on crime deterrence. Upon this approach, we refer to penalties as high or low, meaning 'obviously too low to deter crime' and 'possibly high enough to the deter crime'. The threshold of a 25% detection rate may make the evaluation sound optimistic. However, the classic literature on the economics of crime considers a narrow set of variables. The burden of the enforcement action, including the indirect consequences of the case and charges against employees and business partners, may total up to a situation that companies will indeed try to avoid. That means, considering the whole package of burdens, the enforcement system may manage to deter crime despite low penalties. However, if the penalties are too low (as in the 'low penalty category) it would be naive to expect a deterrent effect of the penalties in any case.

Sanctions and M &As in EU

The purpose of this sub-analysis is to assess whether the antitrust sanctions from the EU Competition Commission may have an impact on the rate of mergers and acquisitions (M &A) within the European Union. The analysis is based on data retrieved from the EU Commission database: antitrust sanction cases and M &A cases from 01/01/2010 to 03/10/2020. Reviewing all antitrust and cartel cases in the period from 1 January 2010 to 10 March 2020, we found 89 cases that resulted in a formal decision. In 73 of the cases that resulted in a sanction, the offenders operated in a clearly distinguished sub-sector (with a unique NACE code), and that fact allowed us to consider systematic variation across sectors. We focus on these 73 cases. 'Sanction' is a dummy variable indicating whether there has been a sanction (sanction =1) or not (sanction =0) in the corresponding level 4 NACE.

We also consider 'Time', the duration in years between the date of the first sanction and the end of the period studied, i.e. 03/10/2020 (the duration is set to 0 in the cases with no sanction). It reflects how long a sector has been operated after a first sanction and therefore its lasting impact. Finally we consider "log(fine)", the logarithm of the amount in euros of the fine imposed by the competition authority when there has been a sanction and 0 otherwise. These three variables all capture the fact that a sanction occurred in a given NACE code sector.

The dependant variable is the number of merger and acquisition (M &A) cases, also grouped by their level 4 NACE codes, corresponding to a specific sub-sector, so that each level 4 NACE code represents an observation. Considering 3,363 M &A cases,[56] the observations fit the negative binomial distribution. To test whether the distribution of observations between the group with sanctions and without is significantly different, we used a Mann–Whitney U test (Wilcoxon test). This was done to

[56] This material is limited to cases notified to the EU Commission under the European Merger Regulation.

test the mean values between the group with sanctions and the group without.[57] The test shows that there is a significant difference in the number of M &A between the two groups.

The average number of M &As is 18.1 in the sectors where an offender is fined for anti-competitive behavior (with a median of 11), while it is 8.1 in other sectors (with a median of 4). This finding suggests a pattern across sectors of M &A cases being far more common (nearly double) in sectors where one or more firms have been sanctioned for anti-competitive behavior, compared to other sectors. Yet there is substantial variation across sectors so that we need to control for the sectors when assessing the impact of the sanction on M &A. In the regressions presented in Table 4 we control for their main (level 1 representing 19 categories) and more detailed (level 2 representing 84 categories) NACE codes.[58]

To further explore the effect of sanction on sectors, we interact sector with sanction. To avoid having too many interaction terms, we group the level 1 sectors that do not have enough observations together: sectors C, D, H, J and K have enough observations to be kept, while the other are grouped together. The effect of sanction and sectors are detailed in Table 7. Column (1) and (2) reproduces the two first column of table 4. Comparing the results with 19 sector controls in column (2) with the 6 grouped sector controls in column (3) we see that the coefficients of sanction are virtually the same. The grouping of sectors with very few observations is not affecting the result on the impact of sanction.

Looking at the 6 categories grouping for level 1 NACE codes, we see in Table 7 column (3) that the annual rate of M &A in sectors C (Manufacturing), D (Electricity, Gas, Steam and Air Conditioning Supply), H (Transportation and Storage), and K (Financial and Insurance Activities), deviate significantly and positively from the omitted category (the group composed of the remaining sectors for which we have only a few observations). This means that independently of the fact that a Sanction was applied, the M &A rate in these sectors is significantly higher than in the omitted category. Note that sectors D, H and K are concentrated sectors with natural monopoly elements (e.g. gas, electricity, transport) and/or regulated sectors (e.g. financial and insurance activities).

The interaction effects in column 4 show that sector C (Manufacturing) and Sector J (Information and Communication) deviate significantly from the omitted category (the group composed of the remaining sectors that received a sanction), which is evidence that in sectors C and J, the Sanction effect is higher than in the other sectors. Sector C coefficient is negative and significant, which suggests that in sector C, there tends to be less M &A in average than in the other sectors. However, when a sanction is applied in this sector, the number of M &A increases by a factor of 2.42

[57] A parametric test would not suit the data since the model is not following a Normal distribution but a Negative binomial distribution. The Mann–Whitney U test uses the ranks to compare the two groups. Since the p-value of the test is smaller than our significance level of 0.05 and $z = -4.631$, we reject the null hypothesis.

[58] The full list of code by level (1 to 4 digit) is available at https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_CLS_DLD &StrNom=NACE_REV2 &StrLanguageCode=EN &StrLayoutCode=HIERARCHIC#.

Table 7 Interacting sanction and sector

	# of M &A Cases by NACE codes			
	(1)	(2)	(3)	(4)
Sanction	0.802*** (6.26)	0.634*** (4.58)	0.613*** (4.45)	− 0.052 (− 0.16)
C			− 0.136 (− 1.44)	− 0.192** (− 1.97)
D			1.133*** (3.62)	1.413** (2.39)
H			0.710*** (3.51)	0.742*** (3.37)
J			0.402** (2.19)	0.212 (1.07)
K			0.996*** (4.81)	1.134*** (4.89)
Sanction × C				0.882** (2.40)
Sanction × D				0.240 (0.32)
Sanction × H				0.316 (0.53)
Sanction × J				1.419** (2.57)
Sanction × K				− 0.395 (− 0.69)
Constant	2.093*** (47.13)	0.745*** (2.82)	1.988*** (31.34)	2.010*** (31.07)
Mean # of M &A	9.24	9.24	9.24	9.24
Sector (19 categories)	No	Yes	No	No
Sector (6 categories)	No	No	Yes	Yes
Observations	643	643	643	643

t statistics in parentheses. *$P < 0.1$, **$P < 0.05$, ***$P < 0.01$

(=exp0.882). The impact of sanction is even stronger in sector J, where the number of M &As is multiplied by 4.13 (=exp1.419) when a sanction is applied. From these observations we infer that, indeed, the sectors play an important role in explaining the impact of sanction on the number of M &A.

To conclude, we find a significant increase in the number of M &A cases when a sanction has been imposed even after adjusting for the effect of sector. While these results confirm the initial finding, the analysis has weaknesses. It was not possible to make comparisons of categories drawn from the same data set. On the one hand, we have data on all the M &A cases submitted to the EU Commission, and on the other hand, we have all the cases of antitrust sanctions by the EU Commission. Hence, the data does not allow for conclusions with respect to the causality between a specific M &A case and a specific sanction. Besides, many M &A cases have been assigned several NACE codes, which means that the sum of M &A cases in the analysis is higher than the actual amount of M &A cases, which means, some NACE codes may be over-represented.

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Declarations

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