THE ECONOMIC JOURNAL

The Economic Journal, **123** (*November*), F545–F557. Doi: 10.1111/ecoj.12079 © 2013 Royal Economic Society. Published by John Wiley & Sons, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA.

THE DISTORTIVE EFFECTS OF ANTITRUST FINES BASED ON REVENUE*

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In most jurisdictions, antitrust fines are based on affected commerce rather than on collusive profits, and in some others, caps on fines are introduced based on total firm sales rather than on affected commerce. We uncover a number of distortions that these policies generate, propose simple models to characterise their comparative static properties and quantify them with simulations based on market data. We conclude by discussing the obvious need to depart from these distortive rules of thumb that appear to have the potential to substantially reduce social welfare.

How competition authorities (CAs) should set fines and how they actually do so in practice is a highly debated issue among antitrust practitioners. In Europe, where fines are often set directly by the CAs, appeal courts have often slashed CAs' decisions precisely on the grounds of how they set the fines. An illuminating example is the UK Competition Appeal Tribunal (CAT) decision in 2011 to cut the fines set by the Office of Fair Trading (OFT) for members of the construction recruitment cartel substantially, on the grounds that the 'wrong' measure of affected commerce was used.

One reason behind these debates is that not only antitrust regulating CAs but also courts, where in charge, use rules of thumb to set the fines that – although well established in the legal tradition and in sentencing guidelines and possibly easy to apply – are very hard to justify and interpret in logical economic terms.

In contrast to what the voluminous literature on optimal fines suggests, starting with Becker's seminal paper (1968), antitrust rules or the practice of CAs in most jurisdictions base fines on affected commerce rather than on unlawful profits (or on the loss of consumer surplus (CS)). As it is hard to find a logical foundation for choosing affected commerce as the benchmark for setting fines, it is no wonder we get surreal conflicts like the one between the CAT and OFT mentioned above. In addition, several jurisdictions impose caps to maximum fines, sometimes linked to firms' total yearly turnover, at other times just 'falling from heaven'.

In this article, we highlight a number of 'distortions' that arise as a result of these policies towards antitrust violations, concentrating on the case of cartels.

A first and obvious distortive effect of fine caps (or fines) linked to total (worldwide) firm revenue is that specialised firms active mostly in their core market expect lower fines (when caps bind) than more diversified firms active in several other markets than the relevant one.

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We are grateful to David Ulph for important suggestions and to audiences at the ACLE's Behavioural Antitrust workshop in Amsterdam, April 2012, at the CRETE Conference in Milos, July 2012 and at the International Industrial Organisation Conference in Boston, May 2013 for their lively discussions. We also thank the discussant Gordon Klein (DICE) for his valuable comments at IIOC. Katsoulacos acknowledges support by the Economic and Social Research Council (ESRC, UK) under grant RES – 062-23-2211. Spagnolo acknowledges funding from the Swedish Competition Authority (Konkurrenseverket).

As the many (other) distortive effects generated by fine caps have been widely discussed elsewhere, we will consider this distortion only briefly and focus on two other, somewhat less obvious, distortions that occur when the volume of affected commerce is used as a base for calculating antitrust fines:

(*i*) If expected fines are not sufficient to deter the cartel, which seems to be the norm given the number of cartels that CAs continue to discover, fines based on revenue rather than on collusive profits push firms to increase cartel prices above the monopoly level to reduce the penalty, thus exacerbating the anti-competitive harm caused by the cartel;

(*ii*) Firms with low profit/revenue ratio, for example firms at the end of a vertical production chain, expect larger fines relative to the same collusive profits than firms that have a larger profit/revenue ratio, e.g. due to their position at the beginning of the production chain.

In this article, we propose simple models of cartel pricing and antitrust enforcement to characterise these distortions and their comparative static properties; we quantify their likely impact empirically, using simple simulations based on market data; and we discuss the obvious need to take action against them. Section 1 briefly discusses how fines should be set in antitrust, in contrast to current antitrust regulation and sentencing guidelines. Section 2 briefly discusses the first distortion, mainly linked to price caps. Sections 3 and 4, the core of the article, analyse the other two distortions within a simple theoretical model and estimate their likely empirical relevance. Section 5 concludes by discussing how to amend this unsatisfactory situation.

1. Background

1.1. *Optimal Monetary Fines in Antitrust*

One of the fundamental principles of the modern economic analysis of the public enforcement of law, based on the seminal paper by Becker (1968),[1] is that penalties should be set to deter inefficient offences, that is, offences that create greater social welfare harm as compared to the gain for the offender(s).[2] When the crime always produces greater harm than benefit, as is the case for cartels (assuming they do not produce efficiencies), then maximising deterrence net of enforcement cost becomes optimal. Risk aversion may reduce optimal fines but risk neutrality seems a natural assumption in the case of managers and firms and given this, enforcement errors by diluting deterrence imply higher optimal fines than in their absence.[3]

In the case of cartels, the benefits are the discounted expected profits from collusion and harm is equal to the CS loss. Because harm and benefits are very correlated, they are both good proxies of what drives firm managers' decisions – therefore, fines meant

[1] Another early contribution is Stigler (1964). For a very good, relatively recent, extensive review see Polinsky and Shavell (2000).

[2] This is the net social harm to 'others'. See, for example, Landes (1983, p. 656).

[3] See, for example, Polinsky and Shavell (2000, pp. 60–61), This analysis also suggests that we should not use costly imprisonment before having set maximal fines, to save on imprisonment costs; see, for example, Buccirossi and Spagnolo (2007, p. 10).

to achieve efficient deterrence could be based on either one. As the loss of CS is a bit harder to estimate, basing fines on an estimate of collusive profits may be an optimal way to go.

This very simple logic is contradicted by the current fining policy adopted by most jurisdictions, which typically base fines on affected commerce, i.e. on revenue in the relevant market, rather than on collusive profits; they also often impose caps to maximum applicable fines in terms of percentage of overall firm turnover.[4]

1.2. *Real-world Fining Policies: Leading Examples*

In the EU, a violation of the cartel prohibition constitutes an administrative offence. To ensure transparency of this enforcement procedure, the European Commission (EC) published new guidelines in 2006 refining the methodology that has been applied so far (since 1998). Under these penalty guidelines, fines are calculated in the following way: First, the Commission determines a basic amount which may be adjusted afterwards due to aggravating and mitigating elements. The basic amount is calculated by taking into account the undertaking's relevant turnover (of the last year of the cartel), the gravity and the duration of the infringement, as well as an additional amount of about 15%–25% of the value of sales to achieve deterrence. For cartels, the proportion of the relevant turnover is set 'at the higher end of the scale' (2006 EU Guidelines) which is 30%. Additional uplifts or reductions are then made when certain aggravating or attenuating circumstances exist. However, the maximum amount of the fine imposed shall not exceed the cap of 10% of annual worldwide turnover of the undertaking in the preceding business year.

In the US, cartels are prosecuted as criminal offences and sentences are imposed by a non-specialised court. The courts use the US Sentencing Guidelines (USSG) as a consulting tool regarding the appropriate form and severity of punishment for offenders. According to these guidelines, both pecuniary and non-pecuniary penalties may be imposed: fines on firms and individuals, as well as imprisonment of individuals involved in the cartel. With regard to fines on firms, the process of their assessment begins with the calculation of a base fine. To determine the base fine, a percentage of the volume of affected commerce, i.e. of total sales from the relevant market, is taken into account. The USSG suggests that 20% of the volume of affected commerce can be used as a good proxy. This volume of affected commerce covers the entire duration of the infringement. Once the amount of the base fine has been calculated, aggravating and mitigating elements are taken into consideration. However, the final fine for undertakings must not exceed a maximum statutory limit which is the greatest of 100 million US$ or twice the gross pecuniary gains the violators derived from the cartel or twice the gross pecuniary loss caused to the victims.[5]

[4] One reason why most public enforcers have maximum statutory limits is that they are interested in not jeopardising the viability of the convicted firm in future. See Buccirossi and Spagnolo (2007) for a list of reasons why this policy is flawed.

[5] The maximum level of fines against individuals is the greatest of 1 million US$ or twice the gross pecuniary gains or twice the gross pecuniary loss caused to the victims, while a maximum imprisonment sentence can be up to 10 years.

When referring to caps on fines in international cartels, the USSG will use the volume of US affected commerce, unless the undertaking's involvement in the infringement is substantially serious. In this case, worldwide turnover will be considered.

Most other OECD countries follow the lead of the US and EU on one or both dimensions. For example, in the UK the starting point for calculating antitrust fines is a fraction of the relevant turnover, i.e. affected commerce; the cap on fines is set at 10% of the undertaking's global turnover, exactly as is the case in the EU.

2. Distortion 1: Fine Caps Linked to Total Revenue

Our main objective in this article is to examine some of the potential implications for social welfare and also for the incidence of fines in different industries (we will call them all, for short, 'distortions') that result from the current fining policies in the EU, US and most other jurisdictions that follow their lead. The first 'distortion' is linked to fine caps rather than fines themselves, and will only be discussed briefly.

Distortion 1: If total firm turnover is used (either as a base for the fine or for a cap of fines that is binding for at least some firms), those firms that are more diversified, acting in many markets other than the relevant one where the infringement occurs, expect higher fines than firms that have a narrow focus on their core business, i.e. for whom affected revenue in the relevant market is not very different from total revenue.

This somewhat obvious distortion – why should diversified firms active in many markets face higher fines than more narrowly focused firms? – could, in principle, induce firms that are at risk of antitrust legal action, like technology-leading dominant firms, to under-diversify inefficiently to reduce their legal liability.[6]

This distortion reminds us of how firms react, inefficiently increasing leverage, when courts take into account their financial situation when establishing fines, the so-called 'judgment proof' problem; see e.g. Shavell (1986), Che and Spier (2008) and with reference to Antitrust, Buccirossi and Spagnolo (2007, 2008).

We do not believe this is commonly happening; we do hope that antitrust liability concerns are still of secondary importance for the strategic decision of which markets to enter. Still, it is not clear that risking this distortion is necessary for an effective enforcement of competition policy.[7]

Moreover, the ratio of imposing pre-established caps on fines is by itself problematic (Bos and Schinkel, 2006, pp. 673–82). It is apparently justified by the need to not drive infringing firms bankrupt. High fines may lead to bankruptcy, the argument goes, which may be associated with a reduction in the number of active competitors in a market which, *ceteris paribus*, may be an undesirable outcome for competition (not if it increases asymmetry). However, as Buccirossi and Spagnolo (2007, pp. 10–12) stress, this argument is suspect for a number of reasons:

[6] This distortion could in principle be prevented by adjusting probabilities of detection, increasing auditing efforts for industries where firms are less diversified. However, this would not be a solution as long as even firms within the same industry have different degrees of diversification.

[7] There are many additional reasons why such caps are not a sound rule of thumb, some of which are discussed in Buccirossi and Spagnolo (2006, 2007, 2008).

First, in assessing the actual effect that bankruptcy due to high fines has on competition in an industry, one needs to take into account the impact of the level of fines on so-called general deterrence, that is, its impact, through the *ex ante* deterrence of cartels in many other industries, on competition in these other industries, in addition to the one examined.

Second, if bankruptcy procedures are efficient, they could, in a relatively short period of time, lead to the replacement of a 'bankrupt' colluding firm, say firm *A*, by a 'new' firm – firm *A* under new ownership – which then gets a 'fresh start' and may well be less likely to engage in collusive practices, having less 'established connections' with other firms.

Third, designing fining policy so as to avoid bankruptcies may well distort firms' decisions regarding their financial (debt-equity) structure. Specifically, it may induce cartel members to issue more debt, reducing their ability to pay antitrust fines, thus adding a further distortion to the other social costs of collusion.

Allowing for the possibility of decision errors in enforcement provides the basis for another reason against the imposition of high fines. In the presence of decision errors, the assumption that fines are socially costless may be inappropriate to the extent that fines may deter firms from undertaking actions that are socially benign. For example, Katsoulacos and Ulph (2012) show that if a CA makes mistakes[8] and firms face legal uncertainty in that they do not know the true nature of their actions (harmful or benign), nor the estimate of harm that the authority will reach if their actions come under investigation, then in certain cases the optimal fine should be low – indeed, it should be zero. However, it is hard to think that this result could be relevant to the case of 'hardcore' cartels (continuing to assume that these cartels do not generate efficiencies).

Removing caps on fines would eliminate the above-mentioned distortion and possibly increase deterrence. However, if removing fine caps is not politically viable, then the cap should not be related to total firm turnover, as in the EU but to firms' collusive profits or to the CS loss they induce, as in the US.

3. Analysis of Distortion 2: Fines, Revenue and Cartel Pricing

The second distortion we want to discuss is not linked to caps but to sentencing guidelines or analogous regulations suggesting that fines should be linked to affected commerce – i.e. total sales/revenue from the relevant market the year before the conviction. In summary:

Distortion 2: A fining rule proportional to affected commerce – i.e. to total revenue in the relevant market – distorts the price-setting incentives of the cartels that it does not deter, inducing them to increase the cartel's price optimally above the monopoly level.

This effect tends to reduce social welfare relative to a monopolised situation with similar fines related to profits, and potentially even relative to a situation with no fines, due to the distortive effects of the higher price and, in the case where the comparison is to a situation with no fines, the presence of antitrust enforcement costs.

[8] Although it can discriminate, which means that it condemns a 'harmful' action with higher probability than a 'benign' action.

Of course, it could be argued that the practical significance of this distortion is likely to be small because it requires managers of firms involved in cartels to be well-informed and forward-looking and to formulate strategic decisions at a level that may not be easily met in reality.

However: the escalation of fines as a percentage of revenues in recent years on both sides of the Atlantic, as well as the much stronger public emphasis on effective detection and enforcement of antitrust law by CAs (often backed by additional resources), makes it more likely that managers will be anticipating and incorporating into their decisions the potential impact of being investigated and found to be in breach of antitrust law; as we will show below, if managers do adjust their behaviour, taking into account the likelihood that they may face a penalty for acting illegally, the 'cost' of this in terms of the loss in consumers' welfare may well be substantial.

3.1. *Formal Investigation of Distortion 2*

Assume a homogeneous product industry with constant marginal cost c and that the lifetime of a cartel, if it is formed, is normalised to unity. In obvious notation, expected cartel profits are given by the equation:

$$\Pi(Q) = (1-\beta)[R(Q) - cQ] - \beta\delta[R(Q) - cQ] - \beta\delta[\phi R(Q)], \tag{1}$$

where β is the probability of successful enforcement (that is, the probability of detection multiplied by the probability that the CA's investigation leads to a ban and a fine is imposed), φ is the fraction of revenue fined (the CA sets φ exogenously) and δ, $0 < \delta \leq 1$, is the duration of the cartel, i.e. the fraction of time since the cartel was formed that it takes the authority to detect it, investigate it and ban it by imposing a fine. In the economics of crime, it is typically assumed – and this is indeed the natural assumption to make – that $\delta = 1$; i.e. that crimes are detected after they have been committed, so that the criminal gains from it before it is detected, investigated and sanctioned. While there is a strand in the literature that treats economic actions as criminal actions, in the sense of assuming that when these actions are harmful to society, they are detected and banned after their natural lifetime is over and the entire benefit has accrued to those taking the actions, this certainly need not be the case. An economic action has an ongoing dimension to it, so it can be detected, subsequently investigated and a fine can be imposed before its natural life is reached. So, according to (1), the cartel expects to get the entire cartel profit for as long as it is not detected with a probability of $(1 - \beta)$ and it expects to get a fraction δ of the cartel profit minus the fine (φR) if it is detected and banned with a probability of β.[9]

Let us here begin with the assumption that $\delta = 1$ (which is then relaxed) and thus re-write expected profits as:

$$\Pi(Q) = R(Q) - cQ - \beta[\varphi R(Q)].$$

[9] For a more extensive discussion on these issues, see also Katsoulacos and Ulph (2013).

The first order condition (f.o.c.) for maximum profit is as follows:

$$\pi_Q = (1 - \beta\phi)R'(Q) - c = 0, \tag{2}$$

or

$$R'(Q_d^*) - \frac{c}{1-\theta} = 0, \tag{3}$$

where $\theta = \beta\phi$.

Thus, assuming $R''(Q) < 0$ – so there is declining marginal revenue – the second order condition for profit maximisation is satisfied.

Note now that if the fine was on profits, if firms ignored fines or if there were no fines, then the f.o.c. for profit maximisation would be as follows:

$$R'(Q_u^*) - c = 0. \tag{4}$$

So, given declining marginal revenue, comparing (3) to (4), we have the following:

RESULT 1. *$Q_d^* < Q_u^*$, The fine based on revenues distorts output to a lower, more distorted level, relative to the already distorted monopoly output that would emerge if the fine was on profits, or if firms ignored fines, or if there were no fines.*

The result is also shown in Figure 1, in which we illustrate the effect of the imposition of the fine, which shifts the marginal revenue curve downwards and leads to an increase in price from p_1 to p_2.

Furthermore, from (3), we observe the following:

RESULT 2. *The distortion on output generated by fines on revenue is increasing in the marginal cost (c), in the probability of successful enforcement (β) and in the percentage of revenue fined (φ).*

This result can be better shown using the implicit function theorem applied to (2), which gives the following:

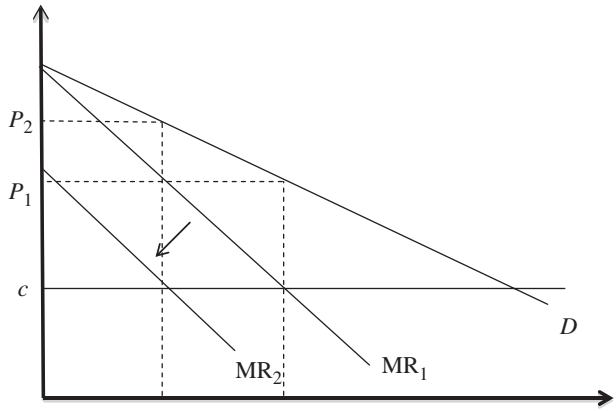

Fig. 1. *Effect on Cartel Price of Fine Based on Revenues*

$$\frac{\mathrm{d}Q}{\mathrm{d}c} = -\left(\frac{\mathrm{d}\pi_Q}{\mathrm{d}Q}\right)^{-1}\frac{\mathrm{d}\pi_Q}{\mathrm{d}c} = \frac{1}{(1-\beta\phi)R''(Q)} < 0,$$

$$\frac{\mathrm{d}Q}{\mathrm{d}\beta} = -\left(\frac{\mathrm{d}\pi_Q}{\mathrm{d}Q}\right)^{-1}\frac{\mathrm{d}\pi_Q}{\mathrm{d}\beta} = \frac{\phi R'(Q)}{(1-\beta\phi)R''(Q)} < 0,$$

and

$$\frac{\mathrm{d}Q}{\mathrm{d}\varphi} = -\left(\frac{\mathrm{d}\pi_Q}{\mathrm{d}Q}\right)^{-1}\frac{\mathrm{d}\pi_Q}{\mathrm{d}\phi} = \frac{\beta R'(Q)}{(1-\beta\phi)R''(Q)} < 0.$$

The comparative static results assume that the representative cartel remains in place while parameters change. However, as higher c, β and φ imply higher expected fines relative to expected collusive profits, the deterrence effect of the policy is also typically increasing in these parameters and, if the cartel is deterred, there will neither be expected fine nor distortions.

We therefore have the following:

RESULT 3. *For a representative cartel, the largest welfare loss linked to distortion is present at intermediate levels of* c, β *and* φ, *where the cartel is not yet deterred but the expected fine is a substantial fraction of revenues.*

As the distortion is only present for cartels that are not deterred, our distortion can be thought of as being – at least partly – self-correcting. An increase in the expected fine will have ambiguous effects in general, as on the one hand it increases the size of the per-cartel distortion, while on the other hand it reduces the number of operating cartels, i.e. of firms subject to the distortion.

The welfare effect is clear at the corners of course. Where enforcement is very poor, because the expected fine is very low, an increase in the expected fine will increase the distortion considerably while having little effect on deterrence. Where enforcement is almost perfect, an increase in the expected fine could lead to full deterrence and the distortion will disappear with cartels.

At intermediate levels of enforcement instead, the effect on welfare caused by an increase in the expected fine will depend on whether the increase in deterrence or the increase in per-cartel distortion will dominate.[10]

It is also illuminating to rewrite (3) in terms of prices, as:

$$p_d^*(1-\varepsilon) - \frac{c}{1-\theta} = 0, \tag{5}$$

where ε is the inverse own-price elasticity of demand. It follows from (5) that:

$$\frac{p_d^*}{c} = \frac{1}{(1-\varepsilon)(1-\theta)}. \tag{6}$$

[10] Of course, an increase in welfare does not preclude that the average price overcharge will not increase as fines increase, because higher fines first deter cartels with lower price overcharges, as shown by Katsoulacos and Ulph (2013).

While, from (4):

$$\frac{p_u^*}{c} = \frac{1}{(1-\varepsilon)}. \tag{7}$$

Thus, we get the following:

RESULT 4. *Comparing (6) and (7), the cartel price overcharge with fines on revenues is higher than the normal monopoly overcharge that would emerge if the fine was on profits or firms ignored fines or if there were no fines.*

From (6), the cartel price overcharge with fines on revenue is increasing in β and φ. On the other hand, from (6) and (7), the magnitude of the price distortion (the ratio of with-fines prices to monopoly prices without fines) due to fines on revenue is independent of the elasticity of demand and is increasing in the probability of successful enforcement (β) and in the percentage of revenue fined (ε).

Given (6), we note that demand elasticities will differ across sectors as well as across jurisdictions. So even assuming the same β across sectors and jurisdictions (which is unrealistic), it is not easy to test empirically whether the price overcharge is being affected by fining policies that involve fines on revenues.

We move now to the general form of (1) and assume that $0 < \delta < 1$. This means that the cartel is detected, an investigation is undertaken and a fine is imposed in a period while the cartel is still active.

So, from (1), now setting

$$\eta = \frac{\beta\varphi\delta}{1-\beta(1-\delta)},$$

the f.o.c. for profit maximisation becomes as follows:

$$R'(Q_d^*) - \frac{c}{1-\eta} = 0.$$

Thus, we get from (8):

RESULT 5. *The larger the duration δ of the cartel (the time that lapses between cartel formation and when the cartel is banned), the larger the distortion generated by a policy of fines based on revenue.*

Note here that while the expected fine is as follows

$$F^e = (\beta\varphi\delta)R(Q_d^*), \tag{9}$$

the loss in CS while the cartel lasts is given by the equation:

$$\mathrm{CS}^{\mathrm{Loss}} = [(1-\beta)+\beta\delta][\mathrm{CS}(Q_d^*) - \mathrm{CS}(Q_u^*)], \tag{10}$$

so we have the following (see also Table 2):

RESULT 6. *Even if expected fines are falling relative to the incidence on consumers due to this fining policy (measured by consumers' surplus loss), the consumer loss ratio can be substantially increasing.*[11]

A question then naturally emerges: how significant is this second distortion?

[11] We are grateful to David Ulph for pointing out and discussing with us this point.

Table 1

Consumer Surplus Loss

CS^{Loss}/CS_u	−1.83%	−3.73%	−5.71%	−7.78%	−9.96%	−12.26%	−14.72%		
β*	0.1	0.2	0.3	0.4	0.5	0.6	0.7		
CS^{Loss}/CS_u	−2.46%	−5.05%	−7.78%	−10.66%	−13.69%				
$\phi^{\dagger}$	0.1	0.2	0.3	0.4	0.5				
CS^{Loss}/CS_u	−1.04%	−2.12%	−3.21%	−4.33%	−5.46%	−6.61%	−7.78%	−10.15%	−11.35%
$\delta^{\ddagger}$	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1

Note. *$\alpha = 100$, $c = 30$, $\varphi = 0.3$, $\delta = 0.7$. $^{\dagger}\alpha = 100$, $c = 30$, $\beta = 0.4$, $\delta = 0.7$. $^{\ddagger}\alpha = 100$, $c = 30$, $\beta = 0.4$, $\varphi = 0.3$.

Table 2

Fine and Consumer Surplus Loss

CS^{Loss}/CS_u	−0.34%	−0.69%	−1.04%	−1.39%	−1.75%	−2.10%	−2.46%	−3.18%	−3.54%
F/CS^{Loss}	−4.31	−4.28	−4.26	−4.24	−4.23	−4.21	−4.20	−4.17	−4.16
δ*	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1

Note. *$\alpha = 100$, $c = 30$, $\beta = 0.4$, $\varphi = 0.1$.

3.2. *Simple Empirically Driven Simulations*

Below we assume a linear inverse demand function, $p(Q) = a - Q$, with $a = 100$ and examine the magnitude of the CS loss for various values of the parameters β, φ and δ (Table 1), as well as the magnitude of the fine to CS loss ratio for a small value of φ, $\varphi = 0.1$, allowing the duration of the cartel to vary (Table 2). As Table 1 indicates, the CS loss due to the distortion can be quite sizable. At the benchmark value of $\varphi = 0.3$, the loss is 7.78% with $\beta = 0.4$ and $\delta = 0.7$. The loss with the same φ and β values rises to 11.35% when there is a large delay in getting the cartel banned, i.e. $\delta = 1$.

As Table 2 indicates while the fine to CS loss ratio is falling (even if slightly) as δ is increasing the CS ratio is increasing very substantially in percentage terms.

4. Analysis of Distortion 3: Revenue and Profit Across Industries

The third distortion we mentioned is linked to the very different ratio between profits or value added and revenue/turnover in different industries and for different firms when they are active in several industries. We can summarise it as follows:

Distortion 3: Firms forming cartels at the end of a long value chain, with a low profit/revenue ratio, expect, *ceteris paribus*, larger fines relative to collusive profits than firms that are either at the beginning of the value chain or are vertically integrated that have a larger profit/revenues ratio.

The importance of this distortion depends on differences across markets and different levels of the production chain. Following a simple formal analysis of this problem we try to quantify the difference in the fines/profit ratio that fine caps can

generate in terms of revenues, using real-world data on revenues and profits for different firms in different sectors.

4.1. *Analysis of Distortion 3*

Consider two industries, A and B, that differ in terms of their collusive profit to revenue ratios, (Π_i/R_i), $i = A, B$. Specifically, assume that:

$$(\Pi_A/R_A) < (\Pi_B/R_B). \tag{11}$$

So, A is the industry with the low profit to revenue ratio. Note that as $\Pi_i = R_i - C_i$, $i = A, B$, where C is total cost, inequality (11) immediately implies that:

$$(C_A/R_A) > (C_B/R_B), \tag{12}$$

that is, A is the industry with the high cost to revenue ratio.

With a policy of fines on revenue, the expected fine in the two industries, if the percentage of revenue fined is the same in both and equal to φ, is as follows:

$$F_i = \varphi R_i, \quad i = A, B. \tag{13}$$

Substituting from (13) into (11) and rearranging yields:

$$(F_A/\Pi_A) > (F_B/\Pi_B). \tag{14}$$

That is,

RESULT 7. *Larger fines relative to collusive profits are imposed on industries with lower profit/revenue ratio* (11) *or on industries with higher cost/revenue ratio* (12).

On the other hand, Beckerian fines or fines as a fraction of profits, which do not distort price decisions, would lead to a fine/profit ratio that is equal for both industries.

This distortion implies that, for example, industries with high R&D (fixed) costs will, *ceteris paribus*, pay higher fines as a fraction of their profit than industries with low R&D costs! Also, industries with large human capital rents that are paid as bonuses out of profits, as e.g. in consultancy, where these payments are not included in costs, pay, *ceteris paribus*, lower fines as a fraction of their profit.

4.2. *Simple Empirically Driven Simulations*

We collected some data on the profit/revenue ratio in different industries where a cartel has been discovered in recent decades to get an idea of how large this third distortion could be. This exercise revealed that the total revenue/profit can range:

(*i*) from the 5.8 of Nippon Electric Glass (convicted by the EU Commission for the cartel of cathode ray tube glass used in television);
(*ii*) to the 12 of Exxon Mobile (convicted by the EU Commission for the cartel on paraffin waxes and slack wax);
(*iii*) to the 91.7 of Unipetrol (convicted by the EU Commission for the cartel on synthetic rubber); and

(*iv*) to the 117.4 of Panasonic (convicted by the EU Commission on household and commercial refrigeration compressors).

This simple exercise suggests that for the very same infringement and the same collusive profits obtained from it (benefits from the cartel), firms in one industry may face, *ceteris paribus*, 20 times larger fines than counterparts in another industry for no logical reason, just because they happen to be at the end of the value chain.

5. Concluding Remarks

Enforcement costs often justify the use of simple rules of thumb that are easier to implement, although they are not optimal. However, as we have seen, basing fines on a firm's affected commerce rather than on collusive profits, and basing fine caps on the firm's total revenue rather than on that from the relevant market, is likely to create large distortions.

Fine caps based on total revenue, as set by the EU Commission, when binding tend to generate much higher fines for more diversified firms, potentially inducing inefficient under-diversification as a means to reduce legal exposure.

Fines based on affected commerce, as required by the USSG and the EU Commission induce undeterred cartels to price higher than they would if fines were based on profits or in the absence of antitrust enforcement.

Moreover, fines based on affected commerce tend to generate much larger fines for firms that are at the end of the value chain, than for firms at the beginning of the value chain or firms that are vertically integrated.

Our empirically based simulations suggest that the deadweight losses produced by these distortions can be very large, and that they may generate fines differing by over a factor of 20 for firms that should instead have the same fine.

It is worth noting that, in the US case, this rule of thumb does not produce any saving in enforcement costs, because the cap on fines prescribed by the USSG requires courts to calculate firms' collusive profits anyway.

It is also worth noting that the distortions we identified are not substitutes, so that either one or the other is present. Instead, they are all present simultaneously and add to one another in terms of poor enforcement.

Developments in economics and econometrics make it possible to estimate illegal profits from an antitrust infringement with reasonable precision or confidence, as regularly done to assess damages. It is time to change these distortive rules of thumb that make revenue so central for calculating fines, if the only thing the distortions buy for us is saving the costs of data collection and illegal profit estimation.

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Submitted: 23 July 2012
Accepted: 13 May 2013

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