Penalising Cartels – A Spectrum of Regimes

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Abstract

There has been much discussion by both academics and policy makers of the most appropriate way of penalising cartels taking account of both the effects of different penalty regimes on welfare as well as various implementation considerations such as ease/cost of implementation and transparency/legal certainty. Consequently there now exists a range of proposed penalty regimes – including two put forward by ourselves. While these can all seem like very distinct regimes, in this paper we show that they can usefully be thought of as lying along a spectrum, inter-connected by the idea of trying to penalise cartels in relation to the damage they cause. They differ in their informational requirements, and in particular whether some key factors needed to calculate the penalty are case-specific or an average across a wide range of cases. Subtle differences in what information is required and how it is used can sometimes cause significant changes in either the welfare or implementation properties of regimes. This new perspective may provide a helpful way of organising the discussion about the pros and cons of the different proposals.

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1. Introduction

There has been much discussion by both academics and policy makers[4] of the most appropriate monetary penalty for Competition Authorities (hereafter CAs) to impose on cartels[5] that CAs have discovered and found to be guilty of infringing antitrust law. The discussion by academic economists has often focussed on the effects of different penalty regimes on welfare[6] – deterrence and the prices set by non-deterred cartels. However CAs often have other implementation considerations such as the ease/cost of implementation and transparency/legal certainty of different regimes which may rank alternative regimes in a somewhat different way from pure welfare concerns.[7]

There now exists a range of actual or proposed penalty regimes, such as the widely used revenue-based regime. In addition there are illegal gains and damages-based regimes as well as the new overcharge-based and sophisticated revenue-based penalty regimes, which we proposed in Katsoulacos et al. (2015) and Katsoulacos et al. (2017), respectively. In this paper we show that these various regimes can all be seen as attempts to penalise antitrust actions in relation to the damage they cause. They do however differ in their informational requirements and in particular whether the determination of the penalty requires case-specific information or can rely on averages across a wide range of cases. Consequently regimes can be thought of as lying along a spectrum which broadly trades off greater ease of implementation against poorer welfare performance. However, we argue that the devil is in the detail: subtle differences in what information is required and how it is used can sometimes cause significant changes in either the welfare or implementation properties of regimes. This new perspective may provide a helpful way of organising the discussion about the pros and cons of the different proposals.

In the next section we briefly set out the framework within which the whole discussion will be framed. Section 3 sets out the spectrum of penalty regimes that have been proposed given the presumption that the aim is to maximise total welfare – producer plus consumer surplus. For each regime we will specify carefully precisely what information the CA needs to obtain in order to calculate a penalty according to that regime, and will then summarise briefly what can be said about both the regime's welfare and implementation properties. Section 4 concludes.

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[4] See, for example, ICN Report (2008), OECD Report (2002), Harrington (2004, 2005), Buccirossi and Spagnolo (2007), Harrington (2010), Houba et al. (2010, 2018), Bageri et al. (2013), Katsoulacos and Ulph (2013), Bageri and Katsoulacos (2014), Dargaud et al. (2015), Katsoulacos et al. (2015, 2017), Bos et al. (2018),

[5] While CAs obviously have to deal with a range of other infringements, much of the discussion of penalties has been grounded in the context of cartels where the infringement entails a very straightforward increase in the price above the level that would have prevailed under competition – the "but-for" price.

[6] See for example the discussion in Katsoulacos et al. (2015) which carried out a systematic comparison of various regimes in terms of welfare.

[7] See for example the discussion in Katsoulacos et al. (2017) which carries out a comparison of various regimes in terms of both welfare and implementations considerations.

2. The Framework

The entire analysis is conducted in the context of the following standard set-up, as illustrated in Figure 1. There is an industry producing a homogeneous final product for which there is a downward-sloping linear demand curve DD. Production takes place under constant average and marginal costs c. If the industry were competitive the price would be $p^B \geq c$ - which we call the "but-for" or counterfactual price. The associated "but-for"/counterfactual output is $Q^B > 0$. If a cartel forms then it is assumed that the entire industry output is sold at the cartel price $p^C > p^B$ and consequently the output sold is Q^C, $0 < Q^C < Q^B$. The price increase brought about by the cartel – the *absolute overcharge* – is $p^C - p^B$. Expressed as a percentage of the "but-for" price this gives the *percentage overcharge* $\theta = \dfrac{p^C - p^B}{p^B}$ and so $p^C = p^B(1+\theta)$

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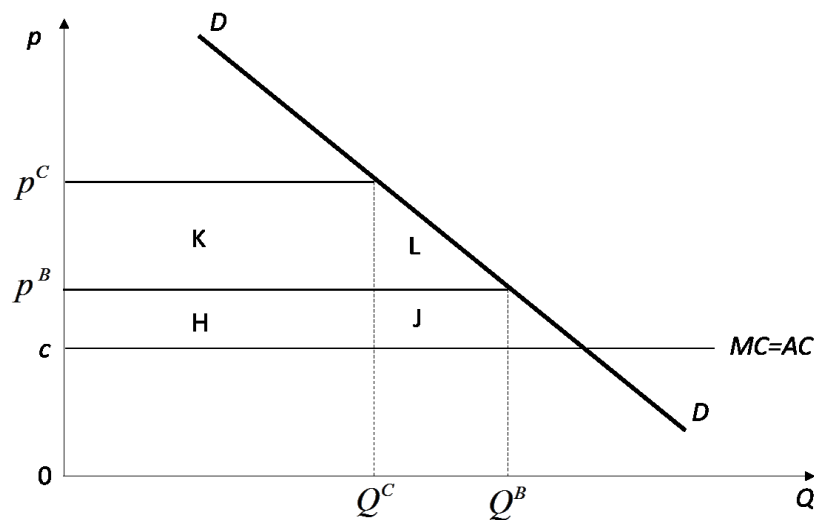
Figure 1

Profits made under competition are given by the area H + J while those under the cartel are given by the area H + K, so the additional profits from cartelisation – *Illegal Gains* – are K – J. The loss of consumer surplus – *Damages* – caused by the cartel are given by the area K + L. Here area K represents the loss of surplus attributable to the fact that, for those units of output that are actually purchased at the cartel price, consumers are paying the inflated cartel price rather than the but-for price, whereas area L represents the loss of consumer surplus arising from those quantities of output that *would* have been bought at the but-for price but are no longer bought at the cartel price. L also represents the Harberger deadweight loss.

Calculating the magnitude of area L intrinsically involves calculating the counter-factual output, Q^B. A useful concept that can come in to play in undertaking this calculation is the arc

elasticity of demand $\eta = \left. \left(\dfrac{Q^B - Q^C}{Q^C} \right) \middle/ \left(\dfrac{p^C - p^B}{p^C} \right) \right.$.[8]

We think of a penalty regime as having two components – a *penalty base*, B and a *penalty rate*, ρ. The magnitude of the financial penalty, F, that is imposed by the CA is obtained by multiplying the two together so $F = \rho B$. A penalty regime is to be thought of as applying across a range of cases which can come from various industries. To be clear about what information is specific to a particular case we will use the index k, while when referring to information that might relate to a particular industry we will use the index i.

If a CA uses a particular penalty regime we take it that in the interests of transparency/certainty it announces the *nature* of the base it intends to use – e.g. cartel revenue – and the principle on which the penalty rate will be determined. However the actual *magnitude* of the base will *always* be calculated on a case-by-case basis. In contrast, as we explain more fully below, the penalty rate may or may not vary from case-to-case.

Finally, in undertaking a welfare comparison of different regimes, it is hard to say much about deterrence since this depends on the level of the penalty rate used under each regime, and one can in principle always choose the penalty rates in such a way that the regimes have equivalent deterrence properties.[9] So we will confine welfare comparisons of the various regimes to what can be said about their impact on the price set by undeterred cartels.

In what follows we consider welfare and implementation properties of six different penalty regimes. One of the considered regimes (namely, the simple revenue-based penalty regime) is the actual cartel enforcement regime, which is currently implemented in many ICN (International Competition Network) countries. According to ICN report (2017), 26 responding agencies relate pecuniary sanctions in cartel cases directly to the value of sales on the relevant market concerned by the infringement, which corresponds to concepts such as relevant turnover or revenue. In the EU, the basis for setting a fine is the value of sales of the goods or services to which the infringement relates.[10] A similar principle is found in the US where the volume of commerce for the entire period of the infringement is taken into account to determine the base fine. The US Sentencing Guidelines provide that 20% of the volume of commerce should be used to calculate the base fine amount.[11]

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[8] Notice that this arc elasticity is evaluated at the cartel price and output. To avoid the possibility of committing the "cellophane fallacy" one could alternatively evaluate the arc elasticity at the "but-for" price and output and so

calculate $\eta = \left. \left(\dfrac{Q^B - Q^C}{Q^B} \right) \middle/ \left(\dfrac{p^C - p^B}{p^B} \right) \right.$.

[9] See Katsoulacos et al. (2015, 2017) for a more detailed discussion and exposition.

[10] See European Commission (2006), *Guidelines on the Method of Setting Fines Imposed*.

[11] See US Sentencing Commission (2018), *Federal Sentencing Guidelines Manual*, Chapter 8.

Some jurisdictions, including the US, also allow for penalties based on the illicit commercial gains obtained through the cartel conduct (see p. 55 of the ICN report (2017)). Such illegal gains-based penalties, under assumption of homogeneous products, can be comparable to recoverable damages based regime analysed in this paper.

Furthermore, responses from most of the agencies in ICN jurisdictions show that the authorities also consider various factors including the gravity/seriousness of the infringement and that the penalty rates are adjusted in light of various aggravating and mitigating factors, including severity of offence. Such an approach brings the cartel penalties closer to the overcharge-based or sophisticated revenue-based penalty regimes discussed below and introduced in Katsoulacos et al. (2015) and Katsoulacos et al. (2017), respectively.

Following ICN report (2017) and other reviews[12] we can conclude that the basis for public penalty calculation in practice can be either percentage of turnover/volume of commerce or illicit gains. Then the penalty base or penalty rate can be adjusted by taking into account severity of offence or other aggravating elements (such as duration, recidivism, ring-leadership, refusal to cooperate) or mitigating elements (effective cooperation, immediate termination, limited participation, negligence). To sum up, case specific information about gravity of the offense related to overcharge can be taken into account for determination of penalty rates. At the same time the rules for setting public penalties for cartels do not rely on case specific information about demand elasticities.[13] As far as we know, for calculating fines in cartel cases, up to now CAs do not try to calculate demand elasticities, since this is not required by the current regime applied.

3. The Spectrum of Regimes

3.1 Pure Damages-Based Regime

The starting point is Becker (1968) who argued that in order to maximise total welfare the appropriate financial penalty to impose on law infringements should be calculated by taking the damage, *D,* caused by any antitrust action that has been detected and prosecuted and dividing by the probability of detection and successful prosecution by a competition authority.[14] Since, under hard core cartels, there are no offsetting benefits, the damage is just the loss of consumer surplus – denoted $-\Delta CS$. So, referring to Figure 1, we can think of this regime as being one under which the *penalty base* in any particular case would be

$$D_k = -\Delta CS_k = \left(p_k^C - p_k^B \right) Q_k^C + \frac{1}{2} \left(p_k^C - p_k^B \right) \left(Q_k^B - Q_k^C \right), \qquad (1)$$

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[12] See e.g. Bageri et al. (2013).
[13] Nevertheless, private cartel enforcement seems to rely heavily on case specific information, including elasticities and case specific but-for prices and output levels. It is not clear how to explain this asymmetry in application of public and private enforcement.
[14] In Becker's framework the price set by a cartel is implicitly taken to be exogenous and independent of the penalty regime, so the only consideration in determining the optimal penalty is to achieve the right amount of deterrence.

while the *penalty rate* is $\rho = \dfrac{1}{\beta}$ where β, $0 < \beta < 1$ is the probability of detection and successful prosecution. To have deterrent effects this has to reflect the probability of detection and prosecution that any cartel contemplating forming would reasonably anticipate, and so might need to vary across industries if firms recognise that CAs devote more resources to investigating and prosecuting actions in some industries than in others. So the penalty rate will not vary from case to case, though it might vary across industries.

Implementation Properties of the Pure Damages-Based Regime

To calculate the base the CA needs information on $p_k^C, Q_k^C, p_k^B, Q_k^B$. We take it that the cartel price and output are readily and accurately observable by the CA and so are going to be pretty costless to obtain, not subject to legal challenge and not a source of legal uncertainty. We also take it that, given the prevalence of private damage claims, there are now well developed techniques of calculating the but-for price, p_k^B. So there should be little legal uncertainty involved as to *how* this might be calculated. Of course there are resource costs to the CA of undertaking the calculation and, given that the firms in the cartel have a good idea of the true value of the but-for price, there could be legal challenges to the precise value that the CA comes up with giving rise to further costs to the CA in defending itself against these challenges. However these costs can be mitigated by asking the firms in the cartel to provide an estimate of p_k^B, appointing some expert to provide an alternative value and then having a legally binding adjudication.[15]

The real informational problems come with determining the but-for output Q_k^B, because, even if there is agreement on p_k^B, the precise value of this output depends on the slope of the demand curve going through the cartel price and output, and so, effectively, on the arc elasticity of demand

$$\eta_k = \left(\frac{Q_k^B - Q_k^C}{Q_k^C} \right) \bigg/ \left(\frac{p_k^C - p_k^B}{p_k^C} \right) . \qquad (2)$$

To see more formally how this elasticity plays a role, substitute (2) into (1) and, after a little re-arranging we get:

$$D_k = -\Delta CS_k = p_k^C Q_k^C \left[\left(\frac{p_k^C - p_k^B}{p_k^C} \right) + \frac{1}{2} \eta_k \left(\frac{p_k^C - p_k^B}{p_k^C} \right)^2 \right]. \qquad (3)$$

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[15] This is not a common approach in fining, in cartel enforcement, precisely because at the moment CAs use simple revenue-based approach, in which estimation of the but-for price and cartel overcharge is not needed. However, this seems to be a common approach in merger cases. It is already done by CAs and academic experts in merger cases where possible pro-collusive effects and efficiency gains / innovation effects are analyzed (see e.g. recent GE/Alstom or DowDuPont merger cases). The fact that such an approach is common for mergers testifies to our proposed penalty regime not been impossible to implement.

Determining the precise elasticity that applies in a particular case could be very costly to determine and defend against legal challenge, for it would require gathering data relevant to the particular market in which the case arose, and then performing some calculations/estimations using that data, where there will be room for disagreement about the precise calculations/estimations performed by the CA.

In addition to implementation issues surrounding the calculation of the base, there could be issues associated with the penalty rate:

- The penalty rate proposed in this section is inversely related to the probability of successful prosecution – for obvious standard reasons. However, having the penalty rate vary across industries could leave a CA open to appeal on the grounds that firms that created the same damage were being subjected to different penalties. For this reason, in what follows, we assume that in practice CAs just use a common/average probability of detection, β, for determining the appropriate penalty rate.
- The optimal penalty rate could be very high, giving rise to bankruptcy concerns. Based on the work of Bryant and Eckard (1991) a widely used figure for the average/common probability of detection is $\beta = 0.15$ [16] which would imply penalties of at least six times damages. This is in contrast with the damages regime in the USA where the starting point for damages claims is triple damages.

Welfare Properties of Pure Damages-Based Regime

If the CA could calculate true damages reasonably accurately and *if* the CA were to apply the appropriate industry-specific penalty rate $\rho = \dfrac{1}{\beta_i}$, then, since, as can be seen from discussion in Section 2, damages are greater than illegal gains, and since firms are likely to know the probability of successful detection and prosecution in their own industry, it follows that firms contemplating forming a cartel would know that under this regime their expected gain from doing so would be eliminated, so all cartels would be deterred from forming and this regime would achieve the first best.

However since, even in the US which uses a damages-based regime, cartels still emerge, we need to consider a second-best world in which the above assumptions do not hold, and any damages-based regime that is used in practice deviates significantly from the first-best regime proposed above. For example, using an average value of β could under-deter cartels in those industries where cartels are known to be investigated and prosecuted at a below average rate.

Obviously, in practice there might be significant differences in the probability of detection and successful prosecution across sectors. The variation could be due to differences in the amount of resources/effort devoted to investigations across sectors which could in turn reflect perceived differences in the importance of various sectors for the economy and the ease/incentives for cartelization in those sectors. In addition, even for a given level of resources, another reason could be that in some sectors, such as on-line markets, where algorithmic collusion is possible, it can be more difficult for competition authorities to detect and prove the existence of cartels. In this paper we take such differences as exogenous and employ the

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[16] See for example Katsoulacos and Ulph (2013), Allain et al. (2015) or Boyer and Kotchoni (2015).

average value of β. Consequently cartels in at least some industries anticipate that their expected illegal gains from forming are positive and continue to form.

There has been little systematic discussion of the welfare properties of damages-based penalty regimes in such a second-best setting, though, as the discussion below makes clear we can say quite a bit when some alternative ways of calculating damages are employed.

3.2   Sophisticated Revenue-Based Penalty Regimes

One simplification that might be forced on a CA when calculating damages according to (3) is to use some average estimate of demand elasticity, η rather than a case-specific one.[17] The average elasticity can be calibrated on the basis of existing empirical studies[18] and estimates produced in antitrust or merger cases. If the CA does this and also uses a penalty rate $\rho = \dfrac{1}{\beta}$ based on the average probability of detection, then the resulting damages-based financial penalty in case k will be:

$$F_k = \left(\frac{1}{\beta}\right)\left\{ p_k^C Q_k^C \left[\left(\frac{p_k^C - p_k^B}{p_k^C} \right) + \frac{1}{2}\eta\left(\frac{p_k^C - p_k^B}{p_k^C} \right)^2 \right] \right\}.$$

Using the definition of the percentage overcharge, θ, one can show that

$$F_k = \left\{ \left(\frac{1}{\beta}\right)\left[\left(\frac{\theta_k}{1+\theta_k} \right) + \frac{1}{2}\eta\left(\frac{\theta_k}{1+\theta_k} \right)^2 \right] \right\}\left(p_k^C Q_k^C \right). \tag{4}$$

so we can interpret this alternatively as a penalty regime in which the penalty base in case k is cartel revenue $R_k^C = p_k^C Q_k^C$ and the penalty rate applied to that base is

$$\rho_k = \rho(\theta_k) \equiv \left(\frac{1}{\beta}\right)\left[\left(\frac{\theta_k}{1+\theta_k} \right) + \frac{1}{2}\eta\left(\frac{\theta_k}{1+\theta_k} \right)^2 \right], \tag{5}$$

and so varies from case-to-case in a way that depends on the (percentage) cartel overcharge in that particular case, but where the function relating the penalty rate to the overcharge is the same across all cases and industries. This illustrates very clearly the point made in the ICN Report (2008) that cartel revenue can be thought of as a measure of cartel damages.

Now a penalty regime in which (i) for any particular case, the penalty base is the cartel revenue and the penalty rate applied to that base depends on the (percentage) cartel overcharge; but (ii) the function relating the penalty rate to the overcharge is the same across all cases and industries, is what Katsoulacos et al. (2017) call a *sophisticated revenue-based penalty regime*.

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[17] Note that case specific elasticities and other case specific information should be available for private damages cases and are definitely available in merger cases. There CAs seem to be able to request all the necessary information to estimate possible pro-collusive effects and efficiency gains.

[18] For example, in their work on optimal cartel penalties Connor & Lande (2012) and Katsoulacos & Ulph (2013) use a value for the elasticity of 1.3, which they got by observing that various studies had produced elasticities in the range $0.95 - 1.65$ and they then just used the average.

So what we have seen is that <u>a damages-based penalty regime which uses an average elasticity to calculate damages and an average probability of detection to calculate the penalty rate, is equivalent to a particular example of a sophisticated revenue-based penalty regime in which the function for determining how the penalty rate varies with the overcharge is given by (5)</u>. This damages-derived function for determining the penalty rate is set out in Katsoulacos and Ulph (2013)[19], but the same approach has been used by others such as Connor and Lande (2008) when discussing the appropriate penalty rate to use in tackling cartels.

Welfare Properties of Sophisticated Revenue-Based Regimes

In their paper, Katsoulacos et al. (2017) show that *any* sophisticated revenue-based penalty regime in which the penalty rate function satisfies the condition that

$$\frac{\rho'(\theta)}{\rho(\theta)} > \frac{1}{\theta(1+\theta)} \text{ for all } \theta \qquad (6)$$

has the desirable property that in <u>every</u> industry the cartel price will be below the monopoly price - the price that would be set by the cartel if there were no competition authority. It is straightforward to check that the penalty rate function defined by (5) satisfies the property in (6), so we can conclude that this particular damages-derived sophisticated revenue-based penalty regime has this welfare property.

Implementation Properties of Sophisticated Revenue-Based Regimes

The penalty base for these regimes is easy to determine. The only other case-specific information these regimes require is the cartel overcharge. We have noted above that there are some implementation issues associated with determining this, and have suggested how these might be mitigated.

The remaining implementation considerations concern the choice of the particular function used to relate the penalty rate to the overcharge. The issues here relate to (i) how easy it is to convey the information about how the penalty rate to be applied for any particular overcharge varies with the magnitude of the overcharge, and (ii) how rapidly the penalty rate rises with the overcharge because the more sensitive this is the more likely it is that appeals will be triggered against whatever estimate of the overcharge the CA comes up with. Since the formula given in (6) has a quadratic term this particular damages-derived penalty rate function is likely to be problematic on both these scores. This leads to a consideration of the following penalty regime.

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[19] To be precise the formula they give in equation (10) of their paper is $\rho = \left(\frac{1}{\beta}\right)\left(\frac{\theta}{1+\theta}\right)\left(1 + \frac{1}{2}\frac{\hat{\eta}\theta}{1-\hat{\eta}\theta}\right)$

where, as discussed in footnote 8 above, $\hat{\eta}$ is the arc elasticity of demand evaluated at the "but-for" price and

output. But it is easy to check that this is exactly equivalent to the formula $\rho = \left(\frac{1}{\beta}\right)\left(\frac{\theta}{1+\theta}\right)\left(1 + \frac{\eta}{2}\frac{\theta}{1+\theta}\right)$

given in (5) where η is the arc elasticity of demand evaluated at the cartel price and output.

3.3   Linear Sophisticated Revenue-Based Penalty Regimes

We now consider a class of regimes that is a special cases of sophisticated revenue-based penalty regimes, but has the important property that the penalty rate just rises in a simple linear relation to the overcharge – i.e.

$$\rho(\theta) \equiv \sigma\theta \qquad\qquad (7)$$

where $\sigma > 0$ is a parameter set in advance by the CA. We discuss below some of the factors that might be taken into account and consequently how σ might be determined.

Welfare properties of linear sophisticated revenue-based regimes.

It is easy to see from (7) that these regimes satisfy condition (6) and so, whatever the value of σ, have the desirable property of always inducing cartels to set a price below the monopoly price.

In Katsoulacos et al. (2017) we also show that this class of regimes has the property that in every industry the fraction of cartels deterred from forming is the same and is directly related to σ. We show that if one wants to achieve the same average level of deterrence as the currently widely used revenue-based penalty regime with a penalty rate of 10% then, depending on what value one assumes for the average overcharge, the value of σ could lie in the range 0.5 – 0.9. This implies that for an industry with the average overcharge the actual penalty rate would vary between 13.5% and 15%.

Implementation properties of linear sophisticated revenue-based regimes.

In terms of informational requirements these regimes have exactly the same properties as the general class of sophisticated revenue-based regimes. In terms of functional form, they are very easy to announce, for the CA just says that if the overcharge is 10% then the penalty rate that will be applied to revenue is $\dfrac{\sigma}{10}$ and for any other overcharge the penalty will vary pro-rata.

However the larger is σ the more sensitive is the penalty rate to the value of the overcharge determined by the CA and the more likely is it that there will be appeals. So this consideration has to be balanced off against deterrence properties.

3.4   Simple Revenue-Based Penalty Regimes

At the other end of the spectrum are what Katsoulacos et al. (2017) call simple revenue-based penalty regimes under which the penalty base is once again cartel revenue but now the penalty rate applied to that is just a pre-announced constant independent of the actual cartel overcharge in any particular case.

One way of determining what this penalty rate should be is to use the formula in (5) but just plug in some measure of the average overcharge. This damages-derived method for determining the penalty rate is used by Katsoulacos and Ulph (2013) and Connor and Lande

(2008), though the precise figures they come up with differ, in large part because of differences in the assumed average overcharge rate.[20]

Implementation properties of simple revenue-based regimes

In terms of informational requirements these are the least demanding and costly of the regimes we consider.

However to the extent that the CA uses a damages-derived penalty rate calculated as above and it is known that this is the basis for determining the penalty rate, this regime is open to appeal on the grounds that a cartel is punished in proportion to the damage caused by others as reflected in the average overcharge rather than in proportion to the damage that it itself has caused as reflected in its own overcharge. In this sense the sophisticated revenue-based penalty regimes might have some implementation advantages over simple revenue-based penalty regimes on the grounds of being perceived to be fairer.

Welfare properties of simple revenue-based regimes

In terms of welfare this is undoubtedly the worst regime. As shown in many papers[21] this regime induces those cartels that do form to set a price above the monopoly price, since effectively it lowers marginal revenue causing the cartel to reduce output and hence drive up the price.

Before concluding this section there are two other penalty regimes we want to briefly introduce and locate on this spectrum.

3.5   Recoverable Damages Based Regime

Given the difficulties of determining the "but-for" output, the way that damages are measured in practice in a wide range of claims cases is to measure just the component of damages that are attributable to the fact that consumers who end up buying the cartel output, Q^C, do so at the cartel price rather than the "but-for" price.[22] This is the part of damages that is reflected in area K in Figure 1 and is what we call recoverable damages, and denote it by $\tilde{D}^c$. So in case k recoverable damages would be $\tilde{D}_k^c = \left(p_k^C - p \right) Q^C$, and so in terms of informational requirements, the only problematic issue is calculating the "but-for" price.

If this were to be used as the base of a penalty regime[23] and if, once again, the penalty rate applied in such a damages-based regime is $\rho = \dfrac{1}{\beta}$ the financial penalty in case k under this

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[20] Katsoulacos and Ulph (2013) suggest a figures of 40% while Connor and Lande (2008) suggest 60%.
[21] For example Katsoulacos and Ulph (2013), Bageri et. al. (2013), Katsoulacos et al (2015, 2017, 2018)
[22] See Brander and Ross (2006, 2017) or Katsoulacos et al. (2018a).
[23] While it might be recognised that this is a possible approximation for damages under a damages-based regime, as far as we are aware, there has been no example of recoverable damages being explicitly used or even proposed as a penalty regime.

regime would be $F_k = \left(\dfrac{1}{\beta}\right)\left(p_k^C - p_k^B\right)Q_k^C$. By comparing this with (4) we see that, since there is no need to measure the but-for output, this regime is equivalent to a pure damages -based regime but with the arc elasticity $\eta = 0$. But then we can modify the statement made above to read <u>a recoverable damages-based penalty regime which uses an average probability of detection to calculate the penalty rate, is equivalent to a particular example of a sophisticated revenue-based penalty regime in which the function for determining how the penalty rate varies with the overcharge is given by (5), but with $\eta = 0$</u>.

If the CA could accurately calculate the damages and *if* it were willing to use the penalty rate set above then, since the area K exceeds the illegal gains $(K - J)$ then this penalty regime could potentially deter all cartels and achieve the first best. However if we are dealing with a second-best world in which cartels form, then we have to consider the prices that these cartels would set and how they are influenced by the penalty. Having a zero elasticity in the formula for the penalty rate function (5) means that there is no quadratic term in the formula, and it is easy to check that this implies that $\dfrac{\rho'(\theta)}{\rho(\theta)} \equiv \dfrac{1}{\theta(1+\theta)}$ for all θ and hence that under this regime the cartel price would always equal the monopoly price. So we see that a recoverable damages-based penalty regime has exactly the same informational requirements as any sophisticated revenue-based penalty regime but is welfare dominated by the linear sophisticated penalty regime proposed above.

3.6   *Overcharge-Based Regime*

In Katsoulacos et al. (2015) we proposed what we called an overcharge-based penalty regime. Like some of the penalty regimes discussed above this can be characterised in a number of equivalent ways, one of which is that the penalty base is "but-for" revenue and the penalty rate applied to that varies with cartel overcharge according to a pre-announced function that is the same across all cases and industries. We proposed a simple proportional function analogous to that in the linear sophisticated revenue-based regime discussed above.

Since the penalty base is affectively a constant that is independent of the cartel price then as long as the penalty rate is any increasing function of the cartel overcharge this regime will have the desirable welfare property of guaranteeing that the cartel price is always below the monopoly price, and so, in that sense, has the same welfare property as the linear sophisticated revenue-based regime proposed above.[24] However since it uses but-for revenue as the base this regime requires calculation of the "but-for" output as well as the "but-for" price and so has all the associated informational problems discussed above in connection with the pure-damages-based regime.

So these two additional regimes each do as well as a linear sophisticated revenue-based regime in one dimension (implementation or welfare) but worse in the other.

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[24] That doesn't mean it has the same welfare level. Calculations we report in Katsoulacos et al. (2018) show that level of welfare in the overcharge-based regime may be higher or lower than that under the linear sophisticated revenue-based regime depending on the parameter values.

4. Conclusions

We have established that there is a spectrum of penalty regimes based on either damages or revenue but connected by the fact that, depending on how the penalty rates are determined under the revenue-based regimes, they are all different ways of trying to penalise cartels in proportion to the damages they cause. The regimes differ in their informational requirements, in particular whether certain key pieces of information needed to calculate the penalty are case-specific or based on some wider population average. They also differ in how that information is used – whether to calculate the penalty base or the penalty rate. So certain damages-based regimes can turn out to be formally equivalent to revenue-based regimes. In that sense some of the differences between regimes can be more apparent than real.

Broadly speaking there is a trade-off between welfare and implementation properties of regimes as we move across the spectrum. However an important message is that the devil is in the details and sometimes quite subtle differences in how information is used can significantly affect welfare and/or implementation properties of regimes.

Our major conclusion is that the preferred regime is the linear sophisticated revenue-based regime. It is significantly better than either the pure damages-based regime or overcharge-based regime in terms of implementation and much better than the widely used simple revenue-based regime in terms of welfare. In particular it has the important feature (shared with all sophisticated revenue-based regimes) of penalising cartels in relation to the overcharge of the particular cartel rather than the average overcharge of all cartels.

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