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Damages for infringements of competition law

Urs Schweizer¹ 

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Abstract

The EU Damages Directive (2014) requires that compensation shall place a person who has suffered harm in the position in which that person would have been had the infringement of competition law not been committed, i.e., firms' actions free of infringements serve as benchmark for specifying harm caused by deviations. The paper confronts this specification with game-theoretic models of market interaction. It is shown that firms are not necessarily deterred to form a cartel that coordinates action choice but non-deterred cartels turn out to be of less concern as they are at least welfare preserving if not enhancing. To implement damages rules that satisfy the Directive's compensation requirement, courts must have sufficient information. When the actions taken by firms cannot be directly observed, implementing the compensation requirements remains possible only if the available evidence is sufficiently informative.

Keywords Infringements of competition law · Damages · Private enforcement · Compensation requirements · Limited evidence

JEL Classification K21 · L13

1 Introduction

1.1 Motivation and main results

To deter infringements of competition law, cartel authorities are empowered to impose fines on infringers. Legal acts of this kind are referred to as public

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enforcement. As an additional instrument, there is also private enforcement with the threat of litigation by private parties. The present paper deals with private enforcement.

Even within the European Union, competition law is national law. But the Directive 2014/104/EU of the European Parliament and of the Council, henceforth referred to as the *Directive*, sets out certain rules to ensure that everyone who has suffered harm caused by an infringement of competition law can effectively exercise the right to claim full compensation. Member states had to adapt national law to this Directive.¹

Article 3 (2) of the Directive explicitly requires that compensation shall place a person who has suffered harm in the position in which that person would have been had the infringement of competition law not been committed. Legal practice has to decide what exactly is meant by this compensation requirement for cases that end up in court.

The present paper, in contrast, confronts the compensation requirement with game-theoretic models of market interaction. It investigates how requirements to compensate victims from infringements in line with Article 3 (2) affect the market outcome and the welfare resulting from it.

At first glance, the approach seems reminiscent of what the economic analysis of tort law has been doing for decades. In tort law, liability rules are seen as a vehicle to fully internalize external effects within all kinds of accident models and models of harm. Full internalization means that the Nash equilibrium of the game induced by a liability rule is efficient in the sense of maximizing welfare. Many versions of negligence rules have been shown to be efficient provided that the negligence standards themselves are set at their efficient levels.

However, there exist substantial differences, the most significant being that damages rules of competition law are not meant to fully internalize external effects. They merely require infringers of competition law to compensate victims for harm caused by such infringements. Instead of the efficient outcome, it is the outcome free of infringements that serves as reference point for quantifying harm caused by a deviation from it.

Only under perfect competition, the outcome free of infringements and, hence, the reference outcome would be efficient. But perfect competition governs market interaction (if at all) only rarely. In any case, competition law tolerates less than perfect competition where the outcome free of infringements does not maximize welfare, i.e., the reference outcome will typically be inefficient.

For illustration, consider market interaction of the Cournot type. Firms choose independently of each other the quantity of a homogenous product that is then sold at the market clearing price. The Cournot equilibrium is inefficient for at least two reasons. First, the total quantity sold is less than what would be supplied under

¹ There exists a Commission staff working document from 2020 that reviews the Directive as required by Article 20(1) of the Directive of 2014. See also Wulf-Henning (2019) who reports how German legislation has reacted to the Directive.

perfect competition and, second, firms may survive under Cournot competition that would be wiped out under perfect competition for their use of an inferior technology.

Nonetheless, if quantity choice is the underlying market interaction then the Cournot equilibrium would qualify as being free of infringements and, for that reason, serves as reference point for quantifying damages. The prime example of an infringement of competition law is when some of the firms form a cartel to coordinate their actions.² If such a cartel reduces supply to raise prices then the non-colluding firms also benefit from it. This is known as the umbrella effect. Customers, however, will suffer from higher prices. To put them in the same position as in the situation free of infringements, they must be entitled to recover the difference of the customers' hypothetical surplus in Cournot equilibrium and their actual surplus given the infringement of competition law committed by the cartel.

As will be shown, such a damages rule need not necessarily deter firms from forming a cartel. But customers will not be worse off as they recover harm caused by the cartel's coordinated choice of actions. Due to the umbrella effect, non-colluding firms will also not be worse off. Therefore, if it is worth for the colluding firms to coordinate their actions in spite of the claims faced by the members of the cartel, it must be due to efficiency gains from reducing the output of those members that operate with an inferior technology. In other words, if the coordination of the quantity choice by the members of the cartel is worth even net of damages claims then welfare of the outcome will not be lower than in the Cournot equilibrium, i.e., in the absence of the infringement.

Far beyond quantity choice in the sense of Cournot, this result is shown to hold for all kinds of market interaction. A damages rule is called compensatory if customers recover harm caused by deviations from the outcome free of infringements and if at least those firms who stick to the action they would have taken in the absence of infringements also recover any possible harm caused to them by the deviation of other firms.³ Suppose a damages rule is in place that is compensatory in this sense. Then the compensation principle established by the present paper shows that rational firms will either be deterred to form a cartel or, if they are not, none of the other market participants will be worse off (after damages). In this latter case, the cartel's coordinated action choice will enhance welfare.

Implementing damages rules that are compensatory in the above sense may not be the ultimate goal of current legal practice. But we will argue why such rules would not contradict the wording of the Directive. Given their desirable properties in terms of welfare, this provides economic support of an interpretation of competition law that enforces the compensation requirements behind the compensation principle as strictly as possible.

To recover harm successfully, claimants must present sufficient evidence to the courts. The Directive, in fact, provides disclosure rules (Articles 5–8 of the

² Forming cartels of injurers does not seem to be a major issue in tort law.

³ This does not mean that non-colluding firms, being aware of the cartel, would not deviate. It just means that they would fully recover if they stick to the action they would have taken without facing coordinated actions by other firms.

Directive) to support claimants in this task.⁴ Nonetheless, courts may have to handle damages claims under less than full information. The present paper also briefly touches upon the implementability of compensatory damages rules under limited information.

As long as courts remain only uncertain about the true level of harm but are still able to observe the actions taken by the firms, then compensatory damages rules can easily be implemented. This is true because, *ex ante*, i.e., when actions are chosen, damages only matter in expected terms and so damages rules must only be compensatory from the *ex ante* perspective for the compensation principle to apply. Such rules can be implemented as long as only the exact level of harm is hidden information but the action choice remains observable.

If, however, the actions of the firms can no longer be directly observed then it may no longer be feasible to implement compensatory damages rules. Difficulties arise at evidence where none of the firms can be ruled out for sure as having kept to the action free of infringements. Under such circumstances, courts can only determine the range of the customers' conceivable harm (or benefit) given such evidence. In the case of firms, the range of harm or benefit must be determined that would be conceivable given the evidence but only under the non-refutable presumption that these firms had chosen their action free of infringements. If such benefits are sufficient to cover harm for any combination of values from these conceivable ranges then a compensatory damages rule can be implemented even if the true actions remain hidden. Yet, to operate such a damages rule, it may be necessary to tolerate overcompensation. The Directive prohibits overcompensation quite generally and, for that reason, may prevent the use of compensatory damages rules even when courts have sufficient information to implement them.

1.2 Related literature

The present paper investigates how the specification of damages for infringements of competition law affects the market outcome. The L&E-literature does not seem to be rich on contributions that directly address the subject of the present paper. In particular, I am not aware of any game-theoretic literature dealing with welfare effects from damages rules that are compensatory relative to an inefficient benchmark.

In fact, the literature on private enforcement of competition law maintains the first-best solution as benchmark. Breit and Elzinga (1985), e.g., whose focus is on private treble damages actions, argue that the economic approach introduces the notion of *efficient offenses*. The Directive certainly does not.

Segal and Whinston (2007), in their survey on public versus private enforcement, posit explicitly that the system's primary objective is to maximize total social welfare. They refer to the EU Green Paper 'Damages actions for breach of the EC

⁴ Article 1(2) highlights that the Directive also aims at fine-tuning the interplay between private damages actions and public enforcement of the EU antitrust rules by the Commission and national competition authorities.

antitrust rules’, which appeared in 2005. While the Directive has grown out of this Green paper, this is a different proposal compared to the Directive.

In any case, damages for infringements of competition law are not meant to eliminate distortions due to imperfect competition in a way that would lead to the efficient (first-best) outcome unless the underlying market structure itself happens to be perfect competition. Only in this case, damages for infringements that put victims in the same position as in the first-best outcome would be in line with the compensation requirement of the Directive. Yet, even for this special case, I am not aware of any literature that examines welfare properties of the market outcome induced by such damages rules.

This is in contrast to the economic analysis of tort law where there exists an extensive literature on games induced by damages rules. From a legal perspective, tort law and competition law may be far apart. From an analytical perspective, however, there are similarities. In fact, if the underlying market structure is perfect competition then the benchmark against which to specify damages is the efficient outcome. If negligence rules of tort law are at stake, it is the efficient outcome that usually serves as negligence standard.

But even from a purely formal perspective, there are differences. First, while formal models of torts explicitly specify the accident probability of an accident and the victim’s loss in case of an accident or even directly the victim’s harm as a function of the precautions chosen by the involved parties, models of market interaction specify profits of firms and the customers’ surplus as functions of the chosen actions by the market participants. Harm is not a primitive element of such models.

For tort law, Grady (1983) distinguishes two regimes: (i) the negligent party is liable for the total loss or (ii) the negligent party is only liable for the loss caused by negligence. While the game-theoretic literature reflects mostly (i), legal systems that apply a negligence standard may go for option (ii). In any case, for models of market interaction, there is no counterpart to option (i) because such models do not specify harm as a primitive concept. The Directive rather explicitly requires to put victims in the same position as in the absence of the infringement, which corresponds to option (ii).

A second difference is interdependence of payoff functions. In a setting with multiple injurers, Kornhauser and Revesz (1989) have shown that negligence rules fully internalize the external effects provided that negligence standards are set at their efficient levels. They assume that precaution costs of injurers (before damages) depend exclusively on the own precaution choice. Profit functions of firms interacting on markets, in contrast, are highly interdependent. For illustration, think of quantity choice in a Cournot model. The market clearing price and, hence, the profit of each single firm depends on the aggregate quantity that, in turn, depends on both the own quantity choice as well as that by all other firms.

The efficiency claim of Kornhauser and Revesz rests on precaution costs that are independent. Interdependence, in fact, changes things substantially as Dharmapala and Hoffmann (2006) have shown. With interdependent precaution costs, negligence rules perform less well. While these authors propose other rules that, in principle, would restore efficiency, according to their view, such rules hardly comply with legal practice. Damages rules, however, would generate efficient incentives quite

generally provided that at least those parties who have chosen their efficient action are compensated for deviations by others. This follows as a by-product from the analysis of the present paper.

Another difference has already been mentioned. Competition law tolerates less than perfect competition and the benchmark for specifying damages rather is how the market would have evolved had there been no infringement. Damages rules that are compensatory relative to this benchmark still provide sufficient incentives so that the resulting market outcome comes with a welfare level not below the one in the absence of infringements. This result is referred to as the compensation principle. The present paper adapts the compensation principle derived by Schweizer (2020) for a two-party tort relationship to the multi-party market interaction introduced in Sect. 3 below and when some of the firms consider to form a cartel.

Segal and Whinston (2007), finally, are pointing out that, in practice, private anti-trust suits often follow public proceedings but they assign a role for follow-on proceedings only if they reveal additional private information of the parties that is used in quantifying damages. McAfee et al. (2005) present a game-theoretic analysis of private versus public antitrust enforcement. They assume right away that a private party has a better signal of the violation than the public agency. The present paper sees room for investigating private enforcement on its own.

1.3 Plan of the paper

Section 2 provides numerical examples generated within a Cournot model to illustrate some of the main findings and to support intuition. Section 3 introduces a general model of market interaction that contains Cournot as a special case. Moreover, it establishes the compensation principle that provides a link between compensation requirements and the resulting incentive and welfare effects. Section 4 revisits the introductory examples of Sect. 2 to illustrate the compensation principle. Section 5 deals with perfect competition as a special case of the underlying market structure. Section 6 shows how compensatory damages rules can be implemented when the firms' actions are observable but the true levels of harm are not. Section 7 provides a sufficient condition, under which a compensatory damages rule can be implemented even when the firms' actions are not directly observable. Section 8 concludes.

2 Introductory examples

The table below summarizes two numerical examples that are generated by a Cournot model with three firms. The examples are used to calculate damages for certain infringements of competition law. The findings are preliminary but provide intuition for the more general results to be derived in subsequent sections.

The three firms $i = 1, 2, 3$ produce and supply a homogenous good to the market. Let x_i denote the quantity contributed by firm i and $x = (x_1, x_2, x_3)$ the action profile listing one quantity for each firm. Total supply amounts to $Q(x) = x_1 + x_2 + x_3$ and is sold at the market clearing price $f(x) = 100 - Q(x)$. Marginal costs c_i of production

are constant and, hence, the profit of firm i is $P_i(x) = [f(x) - c_i] \cdot x_i$. Customers' surplus amounts to $V(x) = [Q(x)]^2/2$, welfare to $W(x) = P_1(x) + P_2(x) + P_3(x) + V(x)$. All these terms are functions of the action profile x chosen by the firms.

In Cournot equilibrium, the firms choose their quantities independently of each other and, if rational, they play the Nash equilibrium $x^n = (x_1^n, x_2^n, x_3^n)$ of the 3-person game with payoff functions $P_i(x)$ as specified above. The Nash equilibrium consists of mutually best responses. Due to the assumed linearity, it can be calculated explicitly. We assume that the cost parameters are so that all three firms survive with positive profits. In such a Cournot equilibrium, firm i supplies $x_i^n = (100 - 3 \cdot c_i + c_j + c_k)/4$ to the market and the equilibrium price is $f(x^n) = (100 + c_1 + c_2 + c_3)/4$. Here, j and k refer to the other two firms. Moreover, in Cournot equilibrium, the profit of firm i is $P_i(x^n) = (x_i^n)^2$.

Since firms act independently, the action profile (x_1^n, x_2^n, x_3^n) from the Cournot equilibrium certainly qualifies as being free of infringements of competition law. However, since competition is less than perfect, the profile x^n does not maximize welfare.

Compare this with the situation where firms 2 and 3 form an illegal cartel to coordinate their actions. We assume that $c_2 < c_3$ and that the cartel will make use of the superior technology of firm 2 to produce their combined output.⁵

We assume that the colluding firms maximize joint profits, initially neglecting possible damages claims.⁶ Therefore the outcome will be as in Cournot equilibrium with only two firms, one producing at marginal costs c_1 , the other at marginal costs c_2 . In this equilibrium, firm 1 supplies $\tilde{x}_1 = (100 - 2 \cdot c_1 + c_2)/3$ to the market whereas the cartel contributes $\tilde{x}_2 = (100 - 2 \cdot c_2 + c_1)/3$ and $\tilde{x}_3 = 0$. The action profile is $\tilde{x} = (\tilde{x}_1, \tilde{x}_2, \tilde{x}_3)$ and leads to price $f(\tilde{x}) = 100 - Q(\tilde{x})$. The profit of firm 1 amounts to $P_1(\tilde{x}) = (\tilde{x}_1)^2$ whereas the combined profit of the cartel amounts to $P_2(\tilde{x}) + P_3(\tilde{x}) = P_2(\tilde{x}) = (\tilde{x}_2)^2$. Customers' surplus is $V(\tilde{x}) = (\tilde{x}_1 + \tilde{x}_2)^2/2$ and welfare is $W(\tilde{x}) = P_1(\tilde{x}) + P_2(\tilde{x}) + V(\tilde{x})$.

For illustration, we use numerical values and we distinguish parameter configuration (I) with $c_1 = 30$, $c_2 = 20$ and $c_3 = 30$ from configuration (II) with $c_1 = 50$, $c_2 = 30$ and $c_3 = 55$. Note that $c_2 < \min[c_1, c_3]$ holds in both configurations. The following table lists the numerical values resulting for the two configurations.

No collusion	(I)	(II)	Collusion	(I)	(II)
$f(x^n)$	45,00	58,75	$f(\tilde{x})$	50,00	60,00
$P_1(x^n)$	225,00	76,56	$P_1(\tilde{x})$	400,00	100,00
$P_2(x^n) + P_3(x^n)$	850,00	840,63	$P_2(\tilde{x}) + P_3(\tilde{x})$	900,00	900,00

⁵ The Article 101(3) of the Treaty on the Functioning of the European Union preempts certain restrictive agreements from prohibition when they generate objective economic benefits that outweigh the negative effects. For this reason, our example need not necessarily capture an infringement of competition law. For the purpose of the present article, however, we assume that the cartel authority does not exempt the welfare-enhancing agreement at hand.

⁶ For an analysis where firms anticipate the damages claims they will possibly face, the reader is referred to Sect. 4 below.

No collusion	(I)	(II)	Collusion	(I)	(II)
$V(x^n)$	1512,50	850,78	$V(\tilde{x})$	1250,00	800,00
$W(x^n)$	2587,50	1767,97	$W(\tilde{x})$	2550,00	1800,00

Damages if anticipated would affect the cartel's decision as follows. The deviation $(\tilde{x}_2, \tilde{x}_3)$ from (x_2^n, x_3^n) is assumed to constitute an infringement of competition law by the cartel. Since $P_1(x^n) < P_1(\tilde{x})$ holds for both parameter configurations, the non-colluding firm benefits from the infringement of the other firms due to the price increase from $f(x^n)$ to $f(\tilde{x})$ (umbrella effect). Therefore firm 1 does not suffer any harm.

Customers, in contrast, suffer from the infringement because $V(x^n) > V(\tilde{x})$ holds for both configurations. The colluding firms are jointly liable for harm $V(x^n) - V(\tilde{x})$ caused to the customers. This includes harm from transactions with firm 1 that benefits from selling at the higher price. Such liability is justified because it is the infringement by the cartel that has caused the higher price.

Consider, first, parameter configuration (I). In the absence of collusion, the combined profit of firms 2 and 3 is $P_2(x^n) + P_3(x^n) = 850,00$ whereas, under collusion, it is $P_2(\tilde{x}) + P_3(\tilde{x}) = P_2(\tilde{x}) = 900,00$. So, if it were not for damages claims, collusion would be worthwhile. Yet, since the colluding firms must pay damages $V(x^n) - V(\tilde{x}) = 262,50$ to the customers, collusion is no longer worthwhile to them, in fact $900,00 - 262,50 = 637,50 < 850,00$. Therefore, under configuration (I), such damages if anticipated prevent the cartel from choosing the action $(\tilde{x}_2, \tilde{x}_3)$.

Consider, second, parameter configuration (II). In the absence of collusion, the combined profit of firms 2 and 3 is $P_2(x^n) + P_3(x^n) = 840,63$ whereas, under collusion, it is $P_2(\tilde{x}) + P_3(\tilde{x}) = P_2(\tilde{x}) = 900,00$. Before damages, collusion would certainly be worthwhile. The colluding firms, however, owe damages $V(x^n) - V(\tilde{x}) = 50,78$ to the customers. Since $900,00 - 50,78 = 849,22 > 840,63$ collusion would, in contrast to configuration (I), remain worthwhile even after damages. Therefore, under configuration (II), the damages rule does not prevent the cartel from choosing the action $(\tilde{x}_2, \tilde{x}_3)$. But, since $W(x^n) = 1767,97 < W(\tilde{x}) = 1800,00$, such collusion would not be of much concern, at least not from the welfare perspective. In fact, welfare would increase and customers would fully recover the harm caused by the infringement. The welfare enhancing results from efficiency gains: in the absence of collusion, the inefficient technology c_3 survives Cournot competition but is eliminated by the coordinated action of the colluding firms.

As mentioned in Sect. 1.2 above, some literature takes the efficient solution as hypothetical benchmark to calculate the harm caused by the infringement even if the underlying market interaction falls short of perfect competition. To illustrate the point, consider parameter configuration (II). Under perfect competition, prices would be equal to $c_2 = 30$, the (lowest) marginal cost of production. Output would be $100 - c_2 = 70$, customers' surplus would be 2450,00. Therefore, if customers were to recover $2450,00 - V(\tilde{x}) = 2450,00 - 800,00 = 1650,00$, they would end up with a surplus after damages of 2450,00. Damages of that size would overcompensate customers substantially. Moreover, they would deter firms 2 and 3 from coordinating their action choice in a welfare enhancing way.

While the above findings support basic intuition, they fall short of a full equilibrium analysis. If firms anticipate possible damages claims from their action choice then \tilde{x} will not be the resulting outcome. We come back to this point in Sect. 4 below after having worked out a general principle behind compensation requirements and their effect on incentives in the next section. The results will be established for a general model of market interaction that contains Cournot as a special case.

3 The compensation principle

In the general model, there is a finite set $I = \{1, \dots, I\}$ of firms.⁷ Firm $i \in I$ chooses an action x_i from the set X_i of available alternatives. An action profile $x = (x_1, \dots, x_I) \in X = X_1 \times \dots \times X_I$ consists of one action choice by each firm. Firm i 's profit $P_i(x)$ is a function of the entire action profile x and, for that reason, payoffs are interdependent.

Besides the firms, there is a passive party that does not act strategically but is affected. This party is referred to as customers. Customers remain passive because, by assumption, they have no bargaining power. Let $V(x)$ denote customers' surplus as a function of the action profile x chosen by the firms. Welfare then amounts to $W(x) = V(x) + \sum_{i \in I} P_i(x)$.

Obviously, the Cournot model of the previous section has this structure. But the general model captures equally well price choice in Bertrand models of differentiated products. As we impose no restrictions on the choice sets X_i , multi-dimensional action choice of more sophisticated models of market interaction are covered as well. The sets X_i of available alternatives may even include mixed strategies. This is particularly helpful for situations where Nash equilibria in pure strategies do not exist.

Competition law requires competing firms to reach their strategic decisions independently of each other. In particular, coordinating the choice of actions in an anti-competitive way is forbidden. When rational firms choose their actions independently then the outcome would be the Nash equilibrium $x^n = (x_1^n, \dots, x_I^n)$ of the I -person game with X_i as strategy space and payoff function $P_i(x)$ for firm $i \in I$. No collusive agreements are needed to sustain this Nash equilibrium and, for that reason, it qualifies as being free of infringements of competition law for the same reason as in the Cournot case. Recall that Nash equilibria consist of mutually best responses and, hence, $P_i(x_i, x_{-i}^n) \leq P_i(x^n)$ must hold for all firms $i \in I$ and for all unilateral deviations x_i by firm i from the profile x^n free of infringements.

If there is an infringement of competition law, customers and/or some of the firms may have valid claims. To fix ideas, suppose it is known that the coalition $C \subset I$ of firms has formed an illegal cartel.⁸ By deviating from the profile free of infringements, this cartel may cause harm to the customers (think of reducing

⁷ By a slight abuse of notation, I denotes both the set and the number of firms.

⁸ Think, e.g., of cases where the cartel has previously been detected by public enforcement.

supply to raise prices) or to firms outside the cartel (think of predatory attacks by the members of C against them).

Article 11 (2), in fact, presumes that cartel infringements cause harm but the infringers shall have the right to rebut that presumption. In any case, a damages rule has to quantify the harm that can be recovered by customers and possibly by firms as well as to determine who is liable for it. If firms anticipate the damages rule in place and are rational, the resulting action profile will be a Nash equilibrium of the game induced by this rule.

While incentives are not listed as goals of the Directive, compensation requirements are mentioned explicitly. As a by-product, they affect incentives and the resulting Nash equilibrium as we now want to show.

The compensation principle to be established in this section lists conditions in terms of compensation requirements that are sufficient for a damages rule to generate incentives so that the induced outcome comes with a welfare level not below the one under the action profile free of infringements. If such a damages rule is in place, coordinated action choice need not necessarily be prevented. But if it is not, then it comes with efficiency gains. Compensation requirements as needed for the compensation principle are consistent with the wording of Article 3 (2).

Given the above model of market interaction, a damages rule is called compensatory when it is compensatory on the account of customers and of firms outside the cartel. For the game-theoretic approach, damages must be specified for all action profiles, including highly implausible ones. For some of them, a compensation requirement must be satisfied even on the account of the cartel.

Formally, a damages rule specifies harm $H(x)$ recoverable by customers, harm $H_i(x)$ recoverable by firm $i \in I \setminus C$ as well as harm $H_C(x)$ recoverable by the cartel all as functions of the actually chosen action profile x . On top of it, the rule specifies who is liable for such harm.

No harm is caused and, hence, no claims are valid when all firms stick to the profile x'' free of infringements of competitive law, i.e., $H(x'') = 0$ is assumed for customers, $H_i(x'') = 0$ for firms outside the cartel and $H_C(x'') = 0$ for the cartel.

If the actual profile x deviates from the one free of infringements then, to be compensatory on the account of customers, recoverable harm $H(x)$ should not be lower than the harm caused by the deviation. More precisely, the compensation requirement on the account of customers

$$V(x) + H(x) \geq V(x'') + H(x'') = V(x'') \quad (1)$$

must hold for any action profile x .

Note that, strictly speaking, customers suffer harm only if $V(x'') - V(x) > 0$. According to Article 3 (2) of the Directive, full compensation shall place a person who has suffered harm in *the position* in which that person would have been had the infringement of competition law not been committed. Therefore, if we interpret $V(x'')$ and $V(x)$ as the customers' (hypothetical) position free of infringements and their actual position, respectively, then the compensation requirement (1) is in line with the Directive's provision except that the provision rules out

overcompensation whereas (1) does not. From a rational choice perspective, overcompensation is of less concern as it reinforces incentives.

If $V(x^n) - V(x) \leq 0$ then customers do not suffer or they even benefit from the deviation. When overcompensation is ruled out but benefits are kept for free then customers are entitled to recover $H(x) = \max [V(x^n) - V(x), 0]$. This specification, in particular, would satisfy (1).

Firms from outside the cartel may also be entitled to receive compensation for harm caused, e.g., by predatory attacks of the cartel. For the compensation principle to apply, it is sufficient when only those firms are entitled to fully recover who have kept to the profile free of infringements, i.e., firms i from the set $I^n(x) = \{i \in I \setminus C : x_i = x_i^n\}$. For being compensatory on the account of such firms, the damages rule must satisfy

$$P_i(x) + H_i(x) \geq P_i(x^n) + H_i(x^n) = P_i(x^n) \quad (2)$$

for all action profiles $x \in X$ and for all firms $i \in I^n(x)$.

As in the compensation requirement (1) on the account of customers, compensation requirement (2) on the account of firms does not rule out overcompensation of firms from $I^n(x)$. Except for that, (2) is in line with the Directive. In fact, the deviation by others causes harm (if any) of size $P_i(x^n) - P_i(x_i^n, x_{-i})$ to firm $i \in I^n(x)$. Based on Article 3 (2), firm i is entitled to recover such harm.

Notice if $P_i(x^n) - P_i(x_i^n, x_{-i}) \leq 0$ then firm i does not suffer or even benefits from the deviation. When overcompensation is ruled out but benefits are kept for free then firm i is entitled to recover $H_i(x) = \max [P_i(x^n) - P_i(x), 0]$. This specification, in particular, would satisfy (2).

A full equilibrium analysis requires the specification of damages for any action profile, even for those where the colluding firms stick to the action profile x_C^n free of infringements but the firms outside the cartel deviate with x_{-C} . In this case, for being compensatory on the account of the cartel members, the compensation requirement

$$\sum_{j \in C} P_j(x_C^n, x_{-C}) + H_C(x_C^n, x_{-C}) \geq \sum_{j \in C} P_j(x^n) \quad (3)$$

is required to hold for any deviation x_{-C} by the firms outside the cartel.

A firm $k \in J^n(x) = \{k \in I \setminus C : x_k \neq x_k^n\}$ outside the cartel who has deviated itself may or may not have a valid claim. Details of the arrangement would probably be a difficult legal issue. Fortunately, for the validity of the compensation principle (see proposition 1 below), it does not matter. Hence, for simplicity, we assume that such firms have no claims, i.e., $H_k(x) = 0$ for $k \in J^n(x)$.

After having specified recoverable harm, we now identify those who are liable. The leading case is when the cartel has deviated with $x_C \neq x_C^n$. In this case, we assume that the cartel members are jointly liable for all harm caused by this deviation and the induced game has payoff function $\phi_i(x) = P_i(x) + H_i(x)$ for all firms $i \in I \setminus C$ outside the cartel and

$$\phi_C(x) = \sum_{j \in C} P_j(x) - H(x) - \sum_{i \in I \setminus C} H_i(x)$$

for the cartel.

In the unlikely case that the cartel, by choosing $x_C = x_C^n$, sticks to the profile free of infringements, only deviating firms outside the cartel, i.e., from the set $J^n(x)$, share liability for all harm. Let $s_k \geq 0$ denote the share borne by $k \in J^n(x)$. The game induced by this damages rule has payoff function $\phi_i(x) = P_i(x) + H_i(x)$ for firm $i \in I^n(x)$, payoff -function

$$\phi_k(x) = P_k(x) - s_k \cdot \left[H(x) + \sum_{i \in I^n(x)} H_i(x) \right]$$

for firm $k \in J^n(x)$ where $\sum_{k \in J^n(x)} s_k = 1$ ⁹ and payoff function $\phi_C(x) = \sum_{j \in C} P_j(x) + H_C(x)$ for the cartel.¹⁰

The predicted outcome is an action profile \hat{x} that constitutes a Nash equilibrium of the above game. This outcome has desirable welfare properties provided that the compensation requirements (1), (2) and (3) are all satisfied.

Proposition 1 (compensation principle) *Suppose the coalition $C \subset I$ of firms has formed an illegal cartel and the damages rule in place satisfies the compensation requirements (1), (2) and (3). Let \hat{x} be the resulting Nash equilibrium. Then the welfare $W(\hat{x})$ in Nash equilibrium cannot be lower than the welfare $W(x^n)$ under the action profile x^n free of infringements and, in fact, neither customers nor non-colluding firms, let alone the cartel will be worse off as compared with the action profile x^n free of infringements.*

Proof Since \hat{x} is a Nash equilibrium, no player can gain by unilateral deviations and, in particular, $\phi_i(\hat{x}) \geq \phi_i(x_i^n, \hat{x}_{-i})$ holds for all firms from outside the cartel whereas $\phi_C(\hat{x}) \geq \phi_C(x_C^n, \hat{x}_{-C})$ holds for the cartel.

Moreover, by assumption, the damages rule satisfies the compensation requirements (1), (2) and (3). It then follows that no party who has kept to the reference profile can be worse off than under the action profile free of infringements. In particular, $V(\hat{x}) + H(\hat{x}) \geq V(x^n)$ holds for the customers,

$$\phi_i(\hat{x}) = P_i(\hat{x}) + H_i(\hat{x}) \geq \phi_i(x_i^n, \hat{x}_{-i}) \geq \phi_i(x^n) = P_i(x^n)$$

holds for all firms $i \in I^n(\hat{x})$.

For the remaining compensation requirements, we distinguish the leading case where the cartel has deviated with $\hat{x}_C \neq x_C^n$ from the case where, by choosing $\hat{x}_C = x_C^n$, it has not. Suppose, first, that $\hat{x}_C \neq x_C^n$. If $k \in J^n(\hat{x})$ then

⁹ Member states shall ensure that undertakings which have infringed competition law are jointly and severally liable (Article 11 of the Directive). A co-infringer should have the right to obtain a contribution from other co-infringers if it has paid more compensation than its share. The determination of that share as the relative responsibility of a given infringer is a matter of national law. According to the German 'Act against Restraints of Competition', e.g., this proportion shall depend on the circumstances of the case, in particular, on the extent to which they have caused the harm (§ 33 d (2) GWB).

¹⁰ Remember, the cartel acts like a single player who maximizes joint profits net of damages claims.

$$\phi_k(\hat{x}) = P_k(\hat{x}) \geq \phi_k(x_k^n, \hat{x}_{-k}) = P_k(x_k^n, \hat{x}_{-k}) + H_k(x_k^n, \hat{x}_{-k}) \geq P_k(x^n) = \phi_k(x^n)$$

where the last inequality follows from the corresponding compensation requirement on the account of a non-deviating firm. Moreover,

$$\begin{aligned}\phi_C(\hat{x}) &= \sum_{j \in C} P_j(\hat{x}) - H(\hat{x}) - \sum_{i \in I^n(\hat{x})} H_i(\hat{x}) \geq \phi_C(x_C^n, \hat{x}_{-C}) \\ &= \sum_{j \in C} P_j(x_C^n, \hat{x}_{-C}) + H_C(x_C^n, \hat{x}_{-C}) \geq \sum_{j \in C} P_j(x^n) = \phi_C(x^n)\end{aligned}$$

holds for the cartel. By adding up the above inequalities, we get

$$\begin{aligned}V(\hat{x}) + H(\hat{x}) + \sum_{i \in I \setminus C} \phi_i(\hat{x}) + \phi_C(\hat{x}) &= W(\hat{x}) \\ &\geq V(x^n) + \sum_{i \in I^n(\hat{x})} P_i(x^n) + \sum_{k \in J^n(\hat{x})} P_k(x^n) + \sum_{j \in C} P_j(x^n) = W(x^n)\end{aligned}$$

and the claim is established for the leading case.

Suppose, second, that $\hat{x}_C = x_C^n$. If $k \in J^n(\hat{x})$ then

$$\begin{aligned}\phi_k(\hat{x}) &= P_k(\hat{x}) - s_k \cdot \left[H(\hat{x}) + \sum_{i \in I^n(\hat{x})} H_i(\hat{x}) \right] \geq \phi_k(x_k^n, \hat{x}_{-k}) \\ &= P_k(x_k^n, \hat{x}_{-k}) + H_k(x_k^n, \hat{x}_{-k}) \geq P_k(x^n)\end{aligned}$$

holds for all firms from $k \in J^n(\hat{x})$ whereas, in the second case,

$$\phi_C(\hat{x}) = \sum_{j \in C} P_j(\hat{x}) + H_C(\hat{x}) \geq \sum_{j \in C} P_j(x^n)$$

holds for the cartel. By adding up the corresponding set of inequalities, it follows that $W(\hat{x}) \geq W(x^n)$ holds in the second case as well.

The remaining claims follow immediately from the above inequalities. \square

The above proposition does not claim that compensatory damages rules always prevent collusion.¹¹ It shows, however, when rational firms collude while facing claims according to a damages rule that satisfies the compensation requirements (1), (2) and (3) then the collusive outcome is welfare-preserving or even welfare-enhancing.

No doubt, from a welfare perspective, it seems desirable to implement damages rule that satisfy the above compensation requirements. In fact, the compensation requirements behind compensatory damages rules do not contradict the

¹¹ It does not even show that a Nash equilibrium in pure strategies must exist. Yet, the compensation principle applies also to Nash equilibria in mixed strategies. Such equilibria are known always to exist, at least, when the sets of pure strategies are finite.

compensation requirements of the Directive. Based on the compensation principle, it seems advisable that such requirement are as strictly enforced as possible.

4 Illustration

In this section, we revisit the introductory examples to illustrate the results of the previous section. Recall: firm i from $\{1, 2, 3\}$ chooses quantity x_i ; customers' surplus amounts to $V(x_1, x_2, x_3) = (x_1 + x_2 + x_3)^2/2$ and the profit of firm i (before damages) to $P_i(x_1, x_2, x_3) = (A - c_i - x_1 - x_2 - x_3) \cdot x_i$; the profile $x^n = (x_1^n, x_2^n, x_3^n)$ free of infringements is the Nash equilibrium of the 3-person game with payoff functions P_1, P_2 and P_3 .

As in the introductory examples, we assume that the technology of firm 2 is the most efficient one, i.e., $c_2 < \min[c_1, c_3]$ but that all firms survive Cournot competition, i.e., $P_i(x^n) > 0$ for $i = 1, 2, 3$.

The Cournot equilibrium of this 3-person game is to be compared with the 2-person game where the firms 2 and 3 form an illegal cartel C to coordinate their quantity choice $x_C = (x_2, x_3)$. The joint profit of the cartel is denoted by $P_C(x_1, x_C) = P_2(x_1, x_C) + P_3(x_1, x_C)$.

Damages are specified relative to a hypothetical customers' surplus V^h and hypothetical profits P_1^h and P_C^h of firm 1 and the cartel. So far, in line with Article 3 (2), we have taken surplus and profit from the profile free of infringements as hypothetical benchmarks, i.e., $V^h = V(x^n)$, $P_1^h = P_1(x^n)$ and $P_C^h = P_C(x^n)$. Since some of the literature takes surplus and profit from the first best profile as hypothetical benchmarks, i.e., $V^h = V(x^*)$, $P_1^h = P_1(x^*)$ and $P_C^h = P_C(x^*)$, we discuss this version as well. The action profile x^* maximizes welfare $V(x) + P_1(x) + P_C(x)$ and amounts to $x^* = (0, A - c_2, 0)$, hence, $P_1^h = P_C^h = 0$ and $V^h = (A - c_2)^2/2$.

Given any action profile (x_1, x_C) , customers recover

$$H(x_1, x_C) = \max [V^h - V(x_1, x_C), 0].$$

If firm 1 keeps to the profile free of infringements, it recovers $H_1(x_1^n, x_C) = \max [P_1^h - P_1(x_1^n, x_C), 0]$ whereas the cartel recovers

$$H_C(x_1, x_C^n) = \max [P_C^h - P_C(x_1, x_C^n), 0]$$

when its members keep to the reference profile.

The payoff functions $\phi_1(x_1, x_C)$ and $\phi_C(x_1, x_C)$ of the game induced by the damages rule as introduced in the previous section are as follows. If firm 1 keeps to the reference, the payoff functions are $\phi_1(x_1^n, x_C) = P_1(x_1^n, x_C) + H_1(x_1^n, x_C)$ for firm 1 and $\phi_C(x_1^n, x_C) = P_C(x_1^n, x_C) - H(x_1^n, x_C) - H_1(x_1^n, x_C)$ for the cartel as it is liable for all recoverable harm when firm 1 has kept to the profile free of infringements.

If both firm 1 and the cartel deviate with $x_1 \neq x_1^n$ and $x_C \neq x_C^n$ then only customers recover and, according to the specification of the previous section, the cartel is liable for it. In this case, the payoff functions are

$$\phi_1(x_1, x_C) = P_1(x_1, x_C) \text{ and } \phi_C(x_1, x_C) = P_C(x_1, x_C) - H(x_1, x_C).$$

If, finally, firm 1 deviates but the cartel does not then the payoff functions are

$$\phi_1(x_1, x_C^n) = P_1(x_1, x_C^n) - H(x_1, x_C^n) - H_C(x_1, x_C^n)$$

for firm 1 who is liable for all recoverable harm and

$$\phi_C(x_1, x_C^n) = P_C(x_1, x_C^n) + H_C(x_1, x_C^n)$$

for the cartel who receives compensation when all compensation requirements introduced in the previous section are satisfied.

Finding the Nash equilibrium of the game with these payoff functions is a tedious task that requires tiresome case distinctions. With the quantity profile free of infringements as hypothetical benchmark, in particular, the analysis becomes cumbersome. Fortunately, the welfare statement of proposition 1 (compensation principle) can be established without solving the game explicitly provided that the profile x^n free of infringements serves as reference profile.

Moreover, with this reference profile, the cartel has the incentive to use exclusively its more efficient technology. In fact, claims against the cartel remain the same when the cartel keeps its total supply fixed but shifts it from the less efficient technology of firm 3 to the more efficient one of firm 2. The cartel as a whole benefits from such a shift while customers and firm 1 are indifferent. As the Nash equilibrium \hat{x} consists of mutually best responses, it follows that the profile x^n free of infringements cannot be a Nash equilibrium because, under this profile, the inefficient firm 3 would still supply a positive quantity $x_3^n > 0$ to the market.

In any case, proposition 1 shows that the Nash equilibrium \hat{x} , no matter how exactly it looks like, comes with welfare $W(\hat{x})$ not lower than welfare $W(x^n)$ from the profile free of infringements. Since the inefficient technology of firm 3 is not in use, quite likely, welfare $W(\hat{x})$ strictly exceeds welfare $W(x^n)$ due to the efficiency gains realized by the cartel.

If, in contrast, the efficient profile x^* serves as hypothetical benchmark, such efficiency gains need not be realized anymore. In fact, it turns out that the only Nash equilibrium in the above example is the profile x^n free of infringement where the inefficient technology c_3 would remain in use.

A full proof of this claim would be lengthy without revealing any insight of great generality. We only sketch the proof that x^n is a Nash equilibrium without showing explicitly why it is the only one.

If firm 1 has chosen $x_1 = x_1^n$, what would be the best response by the cartel? We show that, among all responses different from x_C^n , the best one would be to choose $x_C^b = (x_2 = A - c_2, x_3 = 0)$. In fact, in the range $x_1^n + x_2 \leq A - c_1$, firm 1 does not suffer any harm relative to $P_1(x^*) = 0$ but customers do relative to $V(x^*)$ and so the cartel's payoff is

$$(A - c_2 - x_1^n - x_2) \cdot x_2 - [V(x^*) - V(x_1, x_2, 0)]$$

in this range. As this payoff function is increasing as a function of x_2 (its derivative $A - c_2 - x_2$ is positive), it attains its maximum at the upper end of the range.

In the range $A - c_1 \leq x_1^n + x_2 \leq A - c_2$, firm 1 makes a loss and so the choice x_2 from this range may be seen as a predatory attack by the cartel. Since firm 1 has kept to the profile free of infringements, it is entitled to recover its loss. Customers still suffer harm and, hence, the cartel's payoff is

$$(A - c_2 - x_1^n - x_2) \cdot x_2 - [V(x^*) - V(x_1, x_2, 0)] - [P_1(x^*) - P_1(x_1, x_2, 0)]$$

in this range. As this function is increasing in x_2 (its derivative $A - c_2 - x_1^n - x_2$ is positive) the best response by the cartel among all responses different from x_C^n would be $x_2 = A - c_2 - x_1^n$ at the upper end of this second range.

On intuitive grounds, this finding holds for the following reason. No matter what quantity is chosen by the cartel, since customers receive $V(x^*)$ and firm 1 receives $P_1(x^*)$ anyhow, it would be in the best interest of the cartel to maximize welfare.

Yet, with this response, the cartel would make a loss when the efficient profile serves as hypothetical benchmark. By keeping to the profile free of infringements, in contrast, the cartel would make a positive profit. It follows that, in fact, x_C^n is a best response by the cartel when firm 1 has chosen x_1^n .

If the cartel has actually chosen $x_C^n = (x_2^n, x_3^n)$, what would be the best response by firm 1? Recall that the profile x^n free of infringements is the Nash equilibrium of the 3-person game with payoff functions P_1 , P_2 and P_3 . Therefore, in particular, $P_1(x_1, x_C^n) \leq P_1(x^n)$ holds for any x_1 . For some deviations x_1 , firm 1 may even be liable and so its payoff would be reduced even more. It follows that x_1^n is indeed firm 1's best response when the cartel has chosen $x_C = x_C^n$.

This shows that x^n consists of mutually best responses and so it is a Nash equilibrium of the two-person game with P_1 and P_C as payoff functions when the efficient reference profile serves as hypothetical benchmark. Efficiency gains would not be realized as the inefficient technology c_3 remains in use.

5 Perfect competition

In reality, market structures are typically less competitive than perfect competition. But the compensation principle also applies to perfect competition where the action profile free of infringements maximizes welfare. Let $x^* = (x_1^*, \dots, x_I^*)$ denote this profile, also referred to as the efficient one (first-best).

Suppose that a coalition $C \subset I$ of firms still considers to collude by coordinating the action choice. Let us assume that a damages regime is in place that specifies recoverable harm $H^*(x)$ of customers, $H_i^*(x_i^*, x_{-i})$ of firms outside the cartel and $H_C(x_C^*, x_{-C})$ so that the compensation requirements (1–3) are satisfied relative to the efficient profile $x^n = x^*$.

Consider any Nash equilibrium \hat{x} of the game induced by such a damages rule. It follows from proposition 1 that welfare cannot be lower than $W(x^*)$. Since x^* maximizes welfare, it can also not be higher and so $W(\hat{x}) = W(x^*)$ holds for any such

Nash equilibrium \hat{x} . On top of all this, the welfare maximizing action profile x^* itself is a Nash equilibrium as the following proposition shows.¹²

Proposition 2 *Suppose market interaction is governed by perfect competition and a compensatory damages rule is in place but a cartel C of firms considers to coordinate the action choice. Then the welfare maximizing action profile is a Nash equilibrium of the induced game.*

Proof Two things must be shown. First, when all firms outside the cartel choose their efficient action then it is a best response by the cartel to choose their efficient actions as well. Second, when all but one firm outside the cartel and the cartel choose their efficient actions then it is a best response by this one firm to also choose its efficient action.

To prove the first claim, assume that all firms outside the cartel choose their efficient actions, i.e., $x_{-C} = x_{-C}^*$. Then the cartel's profit is

$$\phi_C(x_C, x_{-C}^*) = W(x_C, x_{-C}^*) - V(x_C, x_{-C}^*) - H^*(x_C, x_{-C}^*) - \sum_{i \in I \setminus C} \phi_i(x_C, x_{-C}^*).$$

Since x^* maximizes welfare, $W(x_C, x_{-C}^*) \leq W(x^*)$ must be true. Moreover, since the damages rule is compensatory on the account of customers,

$$-V(x_C, x_{-C}^*) - H^*(x_C, x_{-C}^*) \leq -V(x^*)$$

must hold and since the damages rule is compensatory on the account of firms outside the cartel and since $I^n(x_C, x_{-C}^*) = I \setminus C$,

$$- \sum_{i \in I \setminus C} \phi_i(x_C, x_{-C}^*) \leq - \sum_{i \in I \setminus C} \phi_i(x^*) = - \sum_{i \in I \setminus C} P_i(x^*)$$

must also hold. It then follows that

$$\phi_C(x_C, x_{-C}^*) \leq W(x^*) - V(x^*) - \sum_{i \in I \setminus C} P_i(x^*) = \phi_C(x^*),$$

i.e., x_C^* is a best response by the cartel to the efficient choice x_{-C}^* of the non-colluding firm. This establishes the first claim. The second claim can be established analogously. \square

Specifying damages that satisfy the compensation requirements relative to the efficient action profile are in line with the Directive when perfect competition is the underlying market structure. Typically, however, competition will be less than perfect. It is proposition 1 that also covers less than perfect competition.

¹² Recall that the action profile free of infringements does not have to be a Nash equilibrium when this profile is inefficient.

6 Estimating harm¹³

Courts can implement compensatory damages rules when they have sufficient information. The Directive provides disclosure rules (Articles 5 – 8 of the Directive). Disclosure rules aim at enabling private victims to prove their harm. To be sure, disclosure activities may remain susceptible to strategic misrepresentation. The present paper, though, makes no attempt to model strategic disclosure activities explicitly. As a shortcut, we rather assume that all evidence available to courts is produced by a signal that maps the action profile into realizations of the signal. Signals may be noisy. This is captured by a state-contingent function $\sigma : X \times \Omega \rightarrow S$ that maps any action profile x into evidence $s = \sigma(x, \omega)$. Evidence s is an element of the evidence space S consisting of all possible realizations of the signal. The state space Ω itself is endowed with an exogenously given probability measure π that assigns a probability $\pi\{\Omega'\}$ to any subset $\Omega' \subset \Omega$. For simplicity, evidence and state space are both assumed to be finite sets.

In the present section, we assume that courts can observe the chosen action profile $x \in X$ and the evidence $s \in S$ but not the true state ω . Given evidence s , they only know that the true state must belong to the event $\Omega^s(x) = \{\omega \in \Omega : \sigma(x, \omega) = s\}$. Such an event is a subset of the state space Ω occurring with probability $\pi^s(x) = \pi\{\Omega^s(x)\}$.

To capture the idea that harm caused by deviations is not directly observable anymore, customers' surplus $v(x, \omega)$ and firm i 's profit $p_i(x, \omega)$ are assumed also to be state-contingent functions of the action profile x . Ex ante, expected surplus and profits amount to $V(x) = E[v(x, \omega)]$ and $P_i(x) = E[p_i(x, \omega)]$ for firm $i \in I$. Since expected profits only matter as far as the profile x^n free of infringements of competition law is concerned, this profile is still the Nash equilibrium of the I -person game with payoff functions $P_i(x)$.

Harm caused by deviation x from the profile x^n free of infringements, however, must now be estimated based on the available evidence $s \in S$, the obvious estimate being conditionally expected harm.¹⁴ Therefore the estimated harm ex post¹⁵ of consumers amounts to

$$\delta(x, s) = E[v(x^n, \omega) - v(x, \omega) \mid \Omega^s(x)].$$

Similarly, the estimated harm ex post of firm i outside the cartel amounts to $\delta_i(x, s) = E[p_i(x^n, \omega) - p_i(x, \omega) \mid \Omega^s(x)]$. Estimated harm may be negative, in which case it reflects a benefit caused by the deviation. Finally, we define

¹³ This and the next section rest on Schweizer (2020). While the earlier paper deals with a setting of two parties, the present one extends some of the results to any finite number of players.

¹⁴ Article 17 of the Directive requires member states to ensure that the national courts are empowered to estimate the amount of harm.

¹⁵ Ex post refers to the stage after the signal has produced and revealed the evidence s .

$$\delta_C(x, s) = E \left[\sum_{j \in C} p_j(x^n, \omega) - \sum_{j \in C} p_j(x, \omega) \mid \Omega^s(x) \right]$$

which, if positive, would be the estimated harm ex post, given evidence s , caused by the deviation x from x^n to the coalition C of colluding firms.

Note that, at the profile x^n free of infringements, $\delta(x^n, s) = \delta_i(x^n, s) = \delta_C(x^n, s) = 0$ holds at any evidence.

For lack of more information, an implementable damages rule has to specify recoverable harm $h(x, s)$ of customers and $h_i(x, s)$ of firms i outside the cartel as well as possibly $h_C(x, s)$ of the cartel all as functions of the observable action profile x and the available evidence s but not of the unobservable state ω . Nonetheless, the informational setting of the present section allows to implement damages rules that satisfy the compensation requirements ex post with the consequence that, a fortiori, they satisfy them also ex ante and, for that reason, the prerequisites of the compensation principle are still met. Details are as follows.

When none of the firms deviate then no damages are due, i.e., $h(x^n, s) = \delta(x^n, s) = 0$ for customers, $h_i(x^n, s) = \delta_i(x^n, s) = 0$ for all firms i outside the cartel as well as $h_C(x^n, s) = \delta_C(x^n, s) = 0$ for the cartel.

Next, suppose that the action profile x deviates from x^n . To be compensatory ex post on the account of customers, recoverable harm $h(x, s)$ must satisfy the compensation requirement $h(x, s) \geq \delta(x, s)$ for all action profiles $x \in X$ and at any evidence s that occurs with positive probability $\pi^s(x) > 0$ given that x is the chosen action profile.

To satisfy the prerequisites of the compensation principle, the damages rule must only be compensatory on the account of firm i outside the cartel when firm i has kept to the profile free of infringements. Thus, to be compensatory ex post on the account of such a firm i , the compensation requirement $h_i(x_i^n, x_{-i}, s) \geq \delta_i(x_i^n, x_{-i}, s)$ must be satisfied for all deviations x_{-i} of the other firms and at all evidence s that occurs with positive probability $\pi^s(x_i^n, x_{-i}, s) > 0$.

To be compensatory ex post on the account of the cartel, finally, the compensation requirement $h(x_C^n, x_{-C}, s) \geq \delta(x_C^n, x_{-C}, s)$ must be fulfilled for all deviations x_{-C} of the firms outside the cartel and at all evidence s that occurs with positive probability $\pi^s(x_C^n, x_{-C}, s) > 0$. Keep in mind that this last compensation requirement is relevant only in the unlikely case that the cartel coordinates the action choice as in the profile free of infringements.

For damages rules that are compensatory ex post, the following result can be established.

Proposition 3 *Suppose a cartel C of firms considers to coordinate the action choice. Courts can only observe the chosen action profile x and the evidence s generated by the signal σ but not the state ω . By assumption, the damages rule satisfies the compensation requirements ex post as defined above. Then the expected welfare in the induced Nash equilibrium \hat{x} is not lower than the expected welfare from the action profile x^n free of infringements of competition law.*

Proof The proof is straightforward. Since, for any action profile x and any evidence s , $\Omega = \cup_{s \in S} \Omega^s(x)$ is a partition of the state space Ω consisting of mutually disjoint subsets, it follows from the definition of conditional expectations that

$$E[f(x, \sigma(x, \omega))] = \sum_{s \in S} \pi^s(x) \cdot E[f(x, s) \mid \Omega^s(x)]$$

holds for any function $f(x, s)$, be it recoverable harm, conditionally expected surplus or profit. As the damages rule is assumed compensatory ex post, the expected harm recoverable by customers, by firms outside the cartel and the cartel satisfies the compensation requirements (1–3) ex ante. The claim then follows immediately from proposition 1 (compensation principle). \square

Damages in the above proposition are based on estimates of the harm caused by deviations from the profile free of infringements of competition law. In principle, Article 17 of the Directive allows for estimating harm but only if it is established that a claimant suffered any harm at all.

What exactly does this mean in the situation of the above model? For illustration, consider customers. Suppose the estimated harm $\delta(x, s)$ is positive. Is this sufficient to show that customers have suffered any harm at all? If yes, then Article 17 would allow to prove that customers have suffered harm indeed by just showing that $\delta(x, s)$ is positive. In this case, the proposed damages rule would be in line with Article 17.

If, however, Article 17 requires that only if, at the true but unobservable state ω' , the difference $v(x^n, \omega') - v(x, \omega')$ is positive, it is allowed to estimate harm, then the proposed damages rule would not be in line with Article 17.

In fact, think of the following situation. Given evidence s , estimated harm $\delta(x, s)$ of customers is positive. Then, nonetheless, a state ω' could exist, for which $v(x^n, \omega') - v(x, \omega')$ were negative and so, in this state, customers would not have suffered any harm at all. If interpreted along these lines, then the proposed damages rule would no longer be in line with Article 17.

7 Hidden choice of actions

To deal with hidden action, suppose the realization s of the signal σ is all what courts can observe. If $\pi^s(x) > 0$ then we say that the action profile x is conceivable given evidence s . Courts cannot keep action profiles x and x' apart when both are conceivable given evidence s .

Given this informational environment, implementable damages rule can only be based on the realization s of the signal but not anymore on the actually chosen action profile. In this section, we derive a condition on the informativeness of the signal that would be sufficient to still implement damages rules satisfying the prerequisites of the compensation principle. The approach resembles what economists call mechanism design. But some of the insights gained are also of interest from the perspective of law.

To meet the compensation requirements for sure, we propose that the claimant is entitled to recover the maximum conceivable harm even if this may lead to over-compensation. Parties must then be identifiable who have deviated for sure from the profile free of infringements and, hence, can be held liable for the maximum conceivable harm without violating the prerequisites of the compensation principle.

More precisely, let $\lambda(s)$ denote the set of parties who must have deviated for sure from the profile x^n free of infringements given evidence s . The coalition C belongs to this set $\lambda(s)$ provided that $\pi^s(x_C^n, x_{-C}) = 0$ holds for all deviations x_{-C} by the firms outside the cartel. The firm i outside the cartel belongs to it provided that $\pi^s(x_i^n, x_{-i}) = 0$ holds for all deviations x_{-i} by the other firms.

Next, for given evidence s , we define the sets $i^n(s) = (I \setminus C) \setminus \lambda(s)$ and $j^n(s) = (I \setminus C) \cap \lambda(s)$. Firm i outside the cartel belongs to $i^n(s)$ when it is conceivable that i has kept to the profile free of infringements, i.e., when there exists action choices x_{-i} by the other firms so that $\pi^s(x_i^n, x_{-i}) > 0$. Firm j belongs to $j^n(s)$ when it is known that j must have deviated for sure.

If $C \in \lambda(s)$ then, at evidence s , the coalition C is liable for all recoverable harm whereas if $C \notin \lambda(s)$ then the firms from $j^n(s)$ are jointly liable for it. Firms who cannot be ruled out as having kept to the action profile free of infringements are not liable, thus reflecting *in dubio pro reo*.

The maximum conceivable harm by consumers is the supremum (lowest upper bound) of harm over the set of all action profiles x that are conceivable given evidence s , i.e., $\Delta(s) = \sup_{x: \pi^s(x) > 0} \delta(x, s)$. Hence, if x is the true action profile that has generated evidence s then $\Delta(s) \geq \delta(x, s)$ must hold for sure.

For a firm i from the set $i^n(s)$, the maximum conceivable harm under the premise that i has actually chosen x_i^n amounts to

$$\Delta_i(s) = \sup_{x_{-i}: \pi^s(x_i^n, x_{-i}) > 0} \delta_i(x_i^n, x_{-i}, s).$$

Hence, if $x = (x_i^n, x_{-i})$ is the true action profile that has generated evidence s then $\Delta_i(s) \geq \delta_i(x, s)$ must hold for sure.

If, finally, the cartel does not belong to $\lambda(s)$ then the maximum conceivable harm given evidence s under the premise that C has actually chosen x_C^n amounts to $\Delta_C(s) = \sup_{x_{-C}: \pi^s(x_C^n, x_{-C}) > 0} \delta_C(x, s)$. Again, if $x = (x_C^n, x_{-C})$ is the true action profile that has generated evidence s then $\Delta_C(s) \geq \delta_C(x, s)$ must hold for sure.

Firms that must have deviated for sure are liable for the maximum conceivable harm. Conflicts with the prerequisites of the compensation principle only arise at evidence s where the set $\lambda(s)$ is empty so that neither the cartel nor any firms outside the cartel can be held liable. We refer to such evidence as critical. At critical evidence s , the prerequisites of the compensation principle can still be satisfied provided that it is known for sure that no harm has been caused or, more generally, that conceivable benefits are sufficient to cover conceivable harm for sure. i.e., if

$$\Delta(s) + \sum_{i \in I \setminus C} \Delta_i(s) + \Delta_C(s) \leq 0 \quad (4)$$

is satisfied at any critical evidence s . If this condition is met then the signal is sufficiently informative to allow for implementing a damages rule that satisfies the prerequisites of the compensation principle. This is our next result.

Proposition 4 *Suppose the signal is informative enough so that (4) is satisfied at any critical evidence s . Then a compensatory damages rule can be implemented even if the action profile cannot directly be observed and, hence, the Nash equilibrium \hat{x} of the induced game comes with a welfare level not lower than the one under profile free of infringements.*

Proof As a preliminary step, suppose the firms have actually kept to the profile x^n free of infringements and evidence s has been generated. We claim that, in this case, $\Delta(s) = \Delta_i(s) = \Delta_C(s) = 0$ must be true for the customers as well as for all firms, from within and outside the cartel. In fact, when x^n is the true action profile then $\Delta(s) \geq \delta(x^n, s) = 0$, $\Delta_i(s) \geq \delta_i(x^n, s) = 0$ for all i outside the cartel and $\Delta_C(s) \geq \delta_C(x^n, s) = 0$ for the cartel. It then follows from (4) that even $\Delta(s) = \Delta_i(s) = \Delta_C(s) = 0$ must be true at such evidence.

Next, we now propose the following damages regime. This regime will turn out being compensatory. At evidence s with $\pi^s(x^n) > 0$, no damages are due. According to the above preliminary step, the rule is compensatory ex post at such evidence.

At evidence s where the cartel belongs to $\lambda(s)$, the cartel is liable for harm

$$\max [\Delta(s), 0] + \sum_{i \in i^n(s)} \max [\Delta_i(s), 0]$$

where customers receive $\max [\Delta(s), 0]$ and firm $i \in i^n(s)$ receives $\max [\Delta_i(s), 0]$. Hence, at such evidence, the rule is compensatory ex post for sure.

At evidence, where the cartel does not belong to $\lambda(s)$ but $\lambda(s)$ is not empty, the firms from the set $j^n(s)$ are jointly liable for harm

$$\max [\Delta(s), 0] + \sum_{i \in i^n(s)} \max [\Delta_i(s), 0] + \max [\Delta_C(s), 0]$$

where customers receive $\max [\Delta(s), 0]$, firm $i \in i^n(s)$ receives $\max [\Delta_i(s), 0]$ and the cartel receives $\max [\Delta_C(s), 0]$. Hence, at such evidence, the rule is compensatory ex post for sure.

At any critical evidence s , finally, we define transfer payments so that $t(s) + \sum_{i \in I \setminus C} t_i(s) + t_C(s) = 0$ as well as $t(s) \geq \Delta(s)$, $t_i(s) \geq \Delta_i(s)$ for $i \in I \setminus C$ and $t_C(s) \geq \Delta_C(s)$ are all satisfied. Here, a positive payment means that the corresponding party receives a payment whereas a negative payment means that the party owes the corresponding sum. The system is self-contained as these payments add up to zero. Moreover, the transfer payments satisfy the compensation requirements ex post at such evidence.

As the above damages rule is compensatory ex post at any evidence, a fortiori, it is also compensatory ex ante and, hence, the claim follows from proposition 1. \square

Three remarks are in order. First, implementing compensatory damages rules along the above lines (if feasible at all) is likely to involve overcompensation. Article 3 (3) forbids overcompensation whether by means of punitive, multiple or other types of damages. Therefore this provision, if interpreted in a strict sense, may prevent the implementation of a damages rule that is compensatory *ex post* even if courts would have sufficient information to implement such a rule.

Second, if, at critical evidence s , a party (say, the customers) is known for sure to having benefitted from a deviation, i.e., if $\Delta(s) < 0$ then the damages rule constructed in the above proof may require customers to return part of the conceivable benefit given evidence s and similarly for the other parties. The Directive remains silent on what to do with benefits.

Third, for the compensation principle to apply, it is sufficient when the damages rule is compensatory *ex ante*. Being compensatory *ex post* is a more demanding condition to fulfill. In fact, consider the signal that fully reveals the action profile but only with some fixed probability $0 < r < 1$ lower than one. With probability $1 - r > 0$, the signal reveals nothing. This signal violates the implementability condition of the above proposition but a damages rule can still be implemented that is compensatory *ex ante*: whenever the action profile is revealed, victims are overcompensated (*ex post*) to the degree that they are exactly compensated from the *ex ante* perspective even if they receive no compensation at all when the signal does not reveal the action profile.¹⁶

8 Concluding remarks

This paper has focussed on the specification of damages when it is known that a coalition C of firms has formed an illegal cartel. There exist other infringements of competition law, not committed by a coalition, but by a single firm. Think of a dominant firm that, by a predatory attack, aims at driving competitors out of the market. The compensation principle is easily adapted to such a situation as well.

In any case, damages rules that are compensatory relative to the benchmark free of infringements of competition law have been shown to exhibit desirable properties in terms of welfare. Moreover, they would be in line with the compensation requirement of the EU Damages Directive (2014).

With full information, compensatory damages rules are easily implemented. At less than full information, it may still be possible to implement them. In this case, however, overcompensation should possibly be tolerated. The Directive prohibits overcompensation.

The Directive allows, however, courts to estimate the amount of harm provided it is established that a claimant suffered harm but it is practically impossible or excessively difficult precisely to quantify the harm suffered on the basis of the evidence available. The conclusion from our analysis is more subtle. Estimated harm if positive should be recoverable even if it cannot be established for sure that, under the actual but unknown state of nature, the claimant has suffered any harm at all.

¹⁶ This idea is adapted from Becker (1963).

For situations of limited information, the paper derives an implementability condition. Any signal satisfying this condition is sufficiently informative to implement damages rules that are compensatory ex post for sure. For signals that violate this condition, the paper has no robust policy conclusion to offer. The conjecture rather is that, without this implementability condition, no welfare statements of great generality would generally be valid.

Yet, a closer look at the proofs makes clear that the compensation requirements must be satisfied at selected action profiles only. For this reason, we argue in favour of satisfying the compensation requirements wherever possible. Parties whose deviation has been detected should be held liable to the extent that customers as well as other firms, who cannot be ruled out as having kept to the action profile free of infringements, are compensated for sure, even if this may lead to overcompensation.

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