

SHOULD PRIVATE EXCHANGES OF LIST PRICE INFORMATION BE PRESUMED TO BE ANTICOMPETITIVE?*

Timo Klein[†] and Bertram Neurohr[‡]

February 2023

ABSTRACT: Harrington (2022) provides a novel theory that explains how a private information exchange involving gross list prices can lead to higher transaction prices. On this basis he considers that private list price exchanges between competitors should be presumed to harm competition. The theory, which has received much attention in the context of the EU trucks cartel case, was recently referred to by the UK Competition Appeal Tribunal as a ‘unilateral effects’ theory, given that it involves no coordination once list prices have been exchanged. Unlike conventional collusion, the theory does not rely on a monitoring and retaliation mechanism. Given its novelty and relevance for recent competition cases, we consider it useful to explore its potential limitations. We show that both the scope for and magnitude of harm are sensitive to key modelling parameters such as the number of firms, the degree of product substitutability, and the level of marginal cost—sometimes in opposite directions. We also show that there may be no scope for the anticompetitive effect when firms are capacity constrained. Finally, we discuss several additional qualitative aspects that may undermine the theory of harm: the adaptability of internal pricing processes over time, the lack of verifiability of exchanged list price information (especially when the exchange is private), and possible procompetitive or competitively neutral reasons for the conduct. We conclude that, although Harrington provides an insightful addition to the wider literature on the competitive effects of information exchanges, the effects of list price exchanges are not sufficiently unambiguous to justify a general presumption of competitive harm.

JEL: K21, L13, L41

KEYWORDS: Information Exchange; List Prices; Collusion; Capacity Constraints

* This article represents our views only and not necessarily those of our affiliations. A key motivating case for this article is the EU trucks cartel case, for which we have been and are currently involved on the defendant side in several jurisdictions in our capacity as consultants at Oxera. Neither we nor Oxera have received third-party financial compensation for writing this article. We appreciate valuable comments from and discussions with Willem Boshoff, Joe Harrington, and Johannes Paha, as well as Gunnar Niels, Joseph Bell, Elisa Greene Morales, and other colleagues at Oxera, Vivek Ghosal as editor and an anonymous referee for their constructive comments. Any errors remain our own.

[†] Oxera Consulting LLP and Utrecht University. Email: t.klein@uu.nl. Corresponding author.

[‡] Oxera Consulting LLP. Email: bertram.neurohr@oxera.com.

1. Introduction

There have been several recent cartel cases involving coordination on or exchange of prices that are different from those that customers eventually pay.¹ Such prices relate to, for example, internal gross list prices (relative to which firms remain free to set discounts towards customers) or surcharges (which constitute only one part of the overall customer price). These types of cartel cases raise two key economic questions: (1) Can coordination on such initial or partial prices lead to higher total prices paid by final customers?² (2) Can the mere *exchange of information* on such initial or partial prices lead to higher prices paid by final customers?

As regards coordination on initial or partial prices, there are different theories that aim to explain under what conditions such coordination may lead to higher final prices, even if it leaves firms free to set these final prices.³ However, these theories rely on conventional cartel theory and the associated *Airtours* criteria for cartel stability (in particular sufficient monitoring and retaliation), which may or may not be satisfied in a given context.⁴ What has received little attention in the literature to date, however, is how a mere information exchange might affect initial or partial prices, especially in cases where the *Airtours* criteria are not satisfied. This is tackled by Harrington (2022a) and is also the subject of this article.

The relevance of this question is exemplified by the ongoing EU trucks cartel case—the largest EU cartel infringement to date by fine size and projected damages claims.⁵ The European Commission concluded that from 1997 to 2011 executives of major truck

¹ Examples include high fructose corn syrup, urethane, cement, air freight, air passengers, and railroads. See Harrington (2022a).

² For a recent discussion of the legal treatment and economics of collusion involving partial prices, with a focus on New Zealand, see Noonan (2021).

³ For example, Boshoff and Paha (2021) discuss how various elements from behavioral theory (anchoring, orientation on reference points, and loss aversion) can be used to explain how coordination on list prices can lead to higher final prices by affecting consumer demand. Focusing on the supply side, Harrington (2022b) considers how the coordination between senior managers of competing firms to internally set higher list prices in order to signal higher costs to lower management in charge of price setting can lead to collusive final prices.

⁴ These criteria were first set out in the EU Court of First Instance Decision on Case T-342/99, *Airtours v Commission*, ECR II-2585 (2002), para. 62. In principle, it can be possible to monitor rivals indirectly, through effects on one's own demand (see Green and Porter, 1984), but this will generally tend to be significantly more difficult, in particular if market demand is subject to significant complexities and noise—it is 'easier to achieve when all firms offer the same goods than when they offer highly differentiated products' (Raith, 1996, as cited in Ivaldi et al., 2003).

⁵ European Commission Case AT.39824 – Trucks.

manufacturers had regularly met and exchanged gross list price information.⁶ For the most part the information exchange did not involve net prices.⁷ In addition to exchanging information, manufacturers occasionally agreed gross list price increases: ‘headquarters discussed their pricing intentions, the future gross price increases,... and *occasionally* agreed their respective gross price increases’ [emphasis added].⁸ The conduct also related to delaying the introduction of new emission technologies and the passing on to consumers of costs of emission technologies.⁹ The Commission concluded that the conduct as a whole constitutes an object infringement of Article 101 TFEU.¹⁰

For present purposes we do not focus on the part of the conduct related to emission technologies. As regards the remainder of the conduct, which the Commission referred to as ‘collusive arrangements on pricing and gross price increases’,¹¹ it follows from the above that (i) it involved mostly list prices, not final transaction prices; and (ii) it was for the most part an exchange of list price information (including information on future list price increases), not list price coordination. Following *Harrington 2022(a)*, this article thus focuses on the exchange of gross list price information, which seems to have been the only sustained element of the conduct.

As is well known, there are potential links between information exchanges and collusion. The most basic form of collusion is one where competing firms explicitly agree to set high transaction prices and punish deviations from collusive prices by responding to price reductions with price reductions.¹² But this is only the first of a range of possible collusive

⁶ Commission Decision of 19.7.2016 relating to a proceeding under Article 101 of the TFEU and Article 53 of the EEA Agreement, AT.39824 – Trucks.

⁷ The Commission states that ‘usually no net prices or net price increases were exchanged’. Commission Decision of 27.9.2017 relating to a proceeding under Article 101 of the TFEU and Article 53 of the EEA Agreement, AT.39824 – Trucks, para. 92. Cf. Competition Appeal Tribunal, Preliminary Issue Judgment of 4 March 2020 in Cases no 1284/5/7/18 and 1290-1295/5/7/18 (T), paras. 79-80.

⁸ Commission Decision of 27.9.2017, *op. cit.*, para. 79. See also Competition Appeal Tribunal, Preliminary Issue Judgment of 4 March 2020, *op. cit.*, paras. 79-80.

⁹ The conduct ‘included agreements and/or concerted practices on... the timing and the passing on of costs for the introduction of emission technologies required by EURO 3 to 6 standards’. Commission Decision of 19.7.2016 relating to a proceeding under Article 101 of the TFEU and Article 53 of the EEA Agreement, AT.39824 – Trucks, para. 50.

¹⁰ Commission Decision of 19.7.2016 relating to a proceeding under Article 101 of the TFEU and Article 53 of the EEA Agreement, AT.39824 – Trucks, para. 69.

¹¹ Commission Decision of 19.7.2016 relating to a proceeding under Article 101 of the TFEU and Article 53 of the EEA Agreement, AT.39824 – Trucks, para. 2.

¹² The first game-theoretical formalisation of reward-punishment strategies is Friedman (1971).

practices.¹³ In particular, collusion need not be explicit but can be tacit in the sense that it does not involve any discussion of prices or exchange of sensitive information.¹⁴ Information, in turn, can be exchanged between competitors for a variety of reasons, including the facilitation of subsequent collusion, which may be tacit in all aspects other than the information exchange itself:¹⁵

Sometimes there will be little doubt that information is shared with the aim of forming or supporting a cartel... However, in other situations information exchanges may have more benign motives—for example, the monitoring of industry developments generally, or the provision of information to customers to enable them to plan purchases. Evidence from businesses themselves suggests that communications are frequent: in a recent UK survey, 44 per cent of companies said that they communicated with competitors on a weekly basis, and 9 per cent said that these communications related to prices (IFF Research, 2015). Not all of these communications have anti-competitive motives. Businesses may share certain information to improve performance through benchmarking, or to diffuse industry best practice or a new technology. Sharing information about market demand can allow for better planning of capacity expansion and inventories; many trade associations collect and publish information on market size and trends.

Thus it is possible but not necessarily the case that information is exchanged in order to facilitate collusion.¹⁶

The forms of collusion mentioned above have in common that they are based on the repeated ‘prisoners’ dilemma’ paradigm: Collectively firms are better off colluding, whereas individually they are better off deviating from the collusive outcome. If there is repeated interaction between competitors, it may be possible for them to sustain the

¹³ As noted in Motta (2004), p. 137: ‘Collusive agreements can take different forms: firms might agree on sales prices, allocate quotas among themselves, divide markets so that some firms decide not to be present in certain markets in exchange for being the sole seller in others, or coordinate their behaviour along some other dimension.’

¹⁴ *Ibid.*

¹⁵ Niels et al. (2016).

¹⁶ For a discussion of the competitive effects of information exchanges in general (albeit not information exchanges involving list prices in particular) see Kühn and Vives (1994). For a more recent discussion focusing on horizontal price exchanges, see Harrington and Leslie (2022). The latter does cover list prices, but only as considered by Harrington (2022a), which is the focus of this paper.

collusive outcome in equilibrium by means of a punishment mechanism. For the punishment mechanism to work, firms must be able to monitor and detect deviations from collusive conduct. Hence the relevance of the *Airtours* criteria, in particular sufficient monitoring and an effective punishment mechanism.¹⁷

An important aspect of the trucks market is that the *Airtours* criteria do not appear to hold, as final prices (i.e. transaction prices) are individually and privately negotiated and therefore unlikely to be transparent. In its 2006 MAN/Scania decision, the European Commission notes the ‘general lack of market transparency’ and that ‘the market investigation has shown that individually negotiated rebates are common, a fact which further decreases price transparency’.¹⁸ By contrast, in its 2016 decision in the trucks case the European Commission notes that ‘the truck sector is characterized by a high degree of transparency’. However, as regards transaction prices, this view seems to be based merely on ‘customers spontaneously presenting competitors’ offers in order to negotiate prices’ and mystery shopping,¹⁹ both of which are likely to give information on rival prices on an *ad hoc* basis only. As such they will have only a limited effect on transparency, in particular given that every transaction price is bilaterally negotiated and will thus reflect the customer-specific bargaining situation.²⁰ Thus, if the purpose of the information exchange was to facilitate collusion directly at the level of transaction prices, it would be difficult if not impossible to effectively detect and punish a firm that deviates from the collusive agreement by setting lower transaction prices.

In the trucks case, any theory of harm that is based on the prisoners’ dilemma paradigm and requires the *Airtours* criteria to be satisfied may therefore lack credibility. In this context Harrington (2022a) develops a novel theory of harm in which the mere exchange of price information can lead to supracompetitive equilibrium prices—without requiring the typical monitoring and deterrence mechanism for the stability of the collusive outcome. On this basis he argues that the private exchange of list prices should be presumed to be harmful to consumers. In this article we reflect on the robustness of this

¹⁷ For a discussion of the *Airtours* criteria in the context of explicit collusion, see Oxera (2021).

¹⁸ See the European Commission’s MAN/Scania decision, 20 December 2006, COMP/M.4336, para. 96.

¹⁹ See Commission Decision of 19.7.2016 relating to a proceeding under Article 101 of the TFEU and Article 53 of the EEA Agreement, AT.39824 – Trucks, para. 29.

²⁰ Moreover, information on rivals’ prices provided by customers may not be verifiable, and customers will have an incentive to selectively present only low-price offers; and mystery shopping will relate primarily to quotes from local dealers about the transaction prices of specific trucks, not to large and complex fleet deals negotiated directly with headquarters. This would therefore be unlikely to give a representative sample that is informative about a manufacturer’s overall strategy.

theory and consider whether it justifies a presumption of harm in relation to private exchanges of list price information.

In the conclusion of his paper, Harrington summarizes the narrative behind his theory as follows:

For courts to be convinced that a private information exchange of prices is anticompetitive, there needs to be a general and intuitive narrative. I believe such a narrative is offered here. The private sharing of prices by competitors gives each firm an opportunity to lower its price should it learn that its rival's price is relatively low. In anticipation of the information exchange and such a possible response by rival firms, a firm is incentivized to set and share a supracompetitive price, which could be in the form of a high list price or the addition of a surcharge. Notably, it is the information exchange agreement that creates harm for *it is the anticipation of sharing prices that induces firms to initially set higher prices*. While there is no agreement on prices, there is an agreement to share prices and there lies the unlawful agreement. [emphasis added]

The basic intuition is that (i) if list prices have some commitment value, higher list prices tend to translate to higher final prices, all else equal, and (ii) information sharing induces high list prices by enabling firms to punish low list prices by responding with low final prices.²¹ An important premise of Harrington's theory is therefore that adjusting prices after sharing them is difficult (such that list prices have some commitment value), but not so difficult as to prevent firms from responding to each other's list prices and implementing a punishment mechanism. Harrington shows that under certain assumptions about the profit function as well as certain restrictions of the parameter space, there exists an anticompetitive equilibrium in which firms set and share higher initial prices, leading to inflated final prices.²²

²¹ A paper closely related to Harrington (2022a) in terms of its setup, underlying intuition and results is Janssen and Karamychev (2022). While our present discussion focuses on the former, we would expect most of our analysis to apply to the latter as well.

²² The practical relevance of this theory and narrative is illustrated by the fact that it played a key role in a recent decision by the Amsterdam District Court (12 May 2021, C/13/639718 / HA ZA 17-1255) in a prominent trucks damages case, which dismissed the claim that there was no harm to final purchasers from the trucks cartel infringement.

In this article, we analyze the impact that changes in the underlying model have on this result. We conclude that, although Harrington (2022a) provides an insightful new theory of *potential* anticompetitive effects in relation to the exchange of list prices, whether such an exchange of list prices is actually harmful in a given case depends on various market features and thus remains an empirical and/or factual matter that cannot be settled by theory alone.²³

In Section 2 we show that there is less scope for harm when there are more firms, when products are less substitutable, or when marginal cost is higher. Moreover, the magnitude of harm (i.e. the overcharge)—if it exists—is lower when the cost of adjusting list prices after having shared them is lower, when there are *fewer* firms, when products are *more* substitutable, or when marginal cost is higher. This in itself makes the existence and level of an anticompetitive effect and the associated harm to customers an empirical question.

In Section 3 we show that the theory of harm does not extend to cases where firms strategically set capacity levels and thus engage in differentiated Cournot rather than Bertrand competition. This is because under Cournot competition the punishment mechanism is undermined by the strategic substitutability of quantities, whereas under Bertrand competition strategic complementarity means that low initial prices are ‘punished’ by low best-response final prices of competitors (and high initial prices ‘rewarded’ by high best-response final prices).

In Section 4 we discuss additional factors that can undermine the theory of harm. These include the potential ability and incentive of firms to adapt internal pricing processes, the possible lack of verifiability of any list price information exchanged (in particular insofar as it is exchanged privately), and potential procompetitive or competitively neutral explanations for the list price exchange.

Section 5 concludes. Overall we consider that a case-by-case assessment of the market features—in particular those highlighted here—is generally desirable in the case of private exchanges of list price information.

²³ This is in contrast to ‘hardcore’ cartel infringements such as price fixing, market allocation, and bid rigging, which are by their very nature contrary to competition and generally presumed to cause harm (although the level still depends on the specifics of the case)—see e.g. Oxera (2009), Section 4.1.

The recent judgment by the UK Competition Appeal Tribunal in the trucks case can be used to illustrate how the insights developed in this article could contribute to the overall assessment.²⁴ The Tribunal noted that the European Commission’s decision ‘only included enough detail to establish the Infringement “by object”’ but not to determine ‘how far the Infringement actually extended or operated’.²⁵ The Tribunal nevertheless considered that there were ‘good a priori reasons for expecting the Cartel to have adverse effects on competition and prices’ on the basis that it was an ‘object’ infringement.²⁶ It further considered that the defendant expert had not ‘[dispelled] the possibility’ of an effect and that it is therefore worth conducting an empirical exercise.²⁷ Unfortunately, the Tribunal found that there were significant limitations in the data and ended up taking a ‘broad axe’ approach to estimating effects in which it considered the estimates and arguments from both sides.²⁸

In order to complement the empirical exercise, and to minimize the risk of the final outcome being determined largely by general presumptions around ‘object’ infringements (in particular where data is limited), it is important to consider in detail the concrete theories of harm put forward, to assess their reasonableness and relevance *in the market context*. In relation to the theory of harm in Harrington (2022a)—which was one of two theories of harm discussed by the Tribunal—the market features we highlight can be used to inform on both the likelihood and magnitude of anticompetitive effects. It can therefore serve to refine *a priori* expectations and help decide where within a range of empirical estimates an effect is most likely to be.

Of course, that is not to say that the insights developed here only pertain to the quantification of damages. Depending on the circumstances and evidence in a particular case, the factors discussed here may change the way that a particular list price exchange is interpreted from the outset. This might for example lead a competition authority to find that a particular list price exchange does not constitute an ‘object’ infringement in the first place (for example when list prices are shared to facilitate pricing in the context of endogenous binding capacity constraints, as considered in Section 3). Our findings show

²⁴ Competition Appeal Tribunal, Judgment of 7 February 2023 in Cases no 1284/5/7/18 (T) and 1290/5/7/18 (T).

²⁵ *Ibid.*, para. 300.

²⁶ *Ibid.*, paras. 268 and 288.

²⁷ *Ibid.*, para. 304.

²⁸ *Ibid.*, paras 372 and 479.

that there is significant ambiguity around the competitive effects of list price exchanges. We therefore urge competition authorities and courts to resist prematurely categorizing them generically as ‘object’ infringements, let alone treating them simply as ‘cartels’.²⁹

In this regard it is worth emphasizing the novelty of the theory of harm and noting that the bulk of the extant information exchange literature does not deal with list prices. Depending on the circumstances, list prices may be more or less closely related to final transaction prices. For example, the ‘cost coordination’ theory developed in Harrington (2022b) treats list prices as cost reports. In such a case, a list price exchange is more akin to an exchange of cost information than an exchange of price information. Even the existing literature on information exchange shows that this has ramifications for the anticompetitive potential (or lack thereof) of the information exchange.³⁰ The fact that list prices may be related to final transaction prices only indirectly (and to varying degrees) implies that any anticompetitive effects of transaction price exchanges may not readily carry over to list price exchanges.

In addition to informing damages quantifications and determining whether a list price exchange constitutes an ‘object’ infringement in the first place, in the case of complex conduct, the finding of an infringement might be narrowed down to certain problematic aspects of the conduct (for example coordination rather than information exchange). Particular market features might also be taken into account when determining the gravity of an infringement in the context of deciding on an appropriate fine.

At what stage and to what extent the specifics of the case are to be considered depends on the availability of the evidence as well as the clarity and nature of its implications, as this will determine whether the benefits outweigh the costs of a more case-specific assessment at any given stage of the process. In this regard the insights of the present article are

²⁹ Cf. para. 268 of Competition Appeal Tribunal, Judgment of 7 February 2023, *op. cit.*, where the Tribunal takes a passage from the 2009 Oxera study on *cartel* effects to argue that the conduct in the trucks case, which largely involved an exchange of list prices, was likely to give rise to adverse effects.

³⁰ See for example Kühn and Vives (1994) (pp. 116-117, rules 1 and 2), who propose treating the exchange of individual price or quantity data but not the exchange of other individualized data as an infringement of competition law. Whether list prices fall in the one or other category will depend on the circumstances of the case. Referring to this paper, Harrington and Leslie (2022) note that ‘[t]here is an extensive theoretical literature on the exchange of cost and demand information by firms with market power and the results are ambiguous regarding welfare effects’.

hoped to be of use in determining what market features to consider and what their implications are for the competitive effects of the particular list price exchange at hand.

2. Scope for and magnitude of harm under differentiated Bertrand competition

Harrington (2022a) uses a symmetric differentiated Bertrand model with two firms to demonstrate how the sharing of list prices can give rise to an anticompetitive equilibrium. In the first stage firms set and exchange list prices, and in the second stage they set final prices, incurring a linear cost if the final price differs from the initial price.³¹ To provide relevant comparative statics on the scope for and magnitude of harm, we use a general Shubik–Levitan linear demand to look at the effect of the number of firms and the degree of product substitutability.³² We use this to show how the scope for harm (i.e. the size of the parameter space within which the anticompetitive equilibrium exists) and the magnitude of harm (i.e. the size of the overcharge) depend on the adjustment cost, the number of firms, product substitutability, and marginal cost.

2.1. Model

Let the demand q_i for firm $i \in \{1, 2, \dots, n\}$ be given by

$$q_i(p_i, \sum_{-i} p_j) = \frac{1}{n} [a - bp_i + d(\bar{p} - p_i)] = \frac{1}{n} \left[a - \left(b + \frac{n-1}{n}d \right) p_i + \frac{d}{n} \sum_{-i} p_j \right] \quad (1)$$

where $n \geq 2$ is the number of firms, $p_i \geq 0$ the price of firm i , and \bar{p} the average price of all firms in the market. Parameter $a > 0$ determines the demand intercept, parameter $b > 0$ the own-price sensitivity, and parameter $d > 0$ the cross-price sensitivity (i.e. the degree of product substitutability—with $d = 0$ in the case of unrelated products and $d \rightarrow \infty$ in the case of perfect substitutes).³³

Let the profit for firm i be given by $\pi_i = (p_i - c)q_i$ minus any costs from the adjustment of list prices, where c is the marginal cost and where the parameters are assumed to satisfy

³¹ This linear cost parameter is taken to be exogenous by Harrington. This is a parsimonious way to capture the constraints imposed by an internal pricing process. In Section 4 we discuss how endogenizing this parameter may undermine the theory of harm.

³² Although the assumption of a linear demand form entails a loss of generality relative to Harrington (2022a), our use of Shubik–Levitan demand facilitates an analysis with n firms and in this sense enables us to go beyond Harrington’s two-firm analysis.

³³ See Choné and Linnemer (2020) for a recent discussion of this demand function, which has two desirable characteristics for the purpose of comparative statics. First, total demand in the market does not depend on the number of firms active in the market. This means that any comparative statics related to the number of firms is not driven by a change in total market size. Second, demand does not depend on the substitutability parameter whenever prices are the same (or, more specifically, the price of a firm is equal to the market average). This is in contrast to the demand specification used in Section 6 of Harrington (2022a).

$0 \leq c < a/b$ (as otherwise there would not be any demand for the products even if they were priced at cost).

The stages of the game are as previously explained: first, firms signal their initial list price p_i^I , after which firms may decrease this to a final list price p_i^F at a linear adjustment cost with coefficient $g > 0$. To solve for the subgame perfect equilibrium of this two-stage game, we begin by solving for the optimal final price in the second stage. We follow Harrington in assuming that firms can only decrease price from the initial level.

Taking the notational simplification that $p_i^F = p_i$, the profit function can be written as $\pi_i(p_i, \sum_{-i} p_j) = (p_i - c) \cdot q_i(p_i, \sum_{-i} p_j) - g \cdot [p_i^I - p_i]$, and profit maximization leads to the following best-response function for firm i in the second stage:

$$p_i^{BR}(\sum_{-i} p_j) = \frac{an + gn^2 + [nb + (n-1)d]c + d \sum_{-i} p_j}{2[nb + (n-1)d]} \quad (2)$$

Making use of the symmetry of all firms other than i , it is possible to calculate the ‘partial equilibrium’ best-response price of any other firm j as a function of p_i ,³⁴ which is given by

$$p_j^{BR}(p_i) = \frac{an + gn^2 + [nb + (n-1)d]c + dp_i}{n(2b + d)} \quad (3)$$

and the second-stage equilibrium price as

$$p^* = \frac{an + gn^2 + [nb + (n-1)d]c}{2nb + (n-1)d} \quad (4)$$

which is increasing in the adjustment cost parameter g (i.e. second-stage equilibrium prices are higher if the cost of adjusting initial list prices is higher).

As a result of Harrington’s Lemma 1, which also applies here, a necessary condition for a subgame perfect equilibrium is that the second-stage (final) prices and first-stage (initial) prices are equivalent. For the second-stage equilibrium prices above to also constitute an equilibrium in the first stage, no firm should therefore be better off by decreasing its initial prices—taking into account any subsequent best-response behavior by the other

³⁴ By ‘partial equilibrium’ we mean the equilibrium of other prices for a given price of firm i .

firms in the second stage.³⁵ In other words, the slope of the profit function with respect to p_i should be non-negative at $p_i = p^*$, taking into account ‘partial equilibrium’ best-response behavior of the other firms:

$$\left. \frac{d\pi_i(p_i, p_{-i}^{BR}(p_i))}{dp_i} \right|_{p_i=p^*} \geq 0 \quad (5)$$

Solving for the adjustment cost parameter g in the above inequality gives the following condition for the existence of the anticompetitive equilibrium:

$$g \leq \bar{g} = \frac{(a - bc)(n - 1)d^2}{n[4n^2b^2 + 2(2n - 1)abd + (n - 1)^2d^2]} \quad (6)$$

Given that $\{a, b, d\} > 0$, $c \in [0, a/b)$, and $n \geq 2$, it follows that $\bar{g} > 0$. Thus, consistent with Harrington’s Theorem 3, we have found an upper bound for adjustment costs that is strictly larger than zero and below which the anticompetitive subgame perfect equilibrium exists.

2.2. Scope for any anticompetitive effect

The anticompetitive equilibrium price p^* only exists as a subgame perfect equilibrium whenever the adjustment cost parameter $g \in (0, \bar{g}]$. In other words, the scope for harm is given by the level of \bar{g} .³⁶ It can be shown that this upper bound (and hence the scope for harm) decreases whenever the number of firms n increases, products become less substitutable (d decreases), marginal cost c increases, the own-price sensitivity b increases, or the demand intercept a increases. In particular³⁷

$$\frac{\partial \bar{g}}{\partial n} = \frac{-(a - bc)d^2[(2n - 3)n^2(2b + d)^2 - 2(n - 2)nd(b + d) - d^2]}{n^2[4n^2b^2 + 2(2n - 1)abd + (n - 1)^2d^2]^2} < 0 \quad (7)$$

³⁵ The intuition behind Lemma 1 is that setting initial prices that are higher than final prices would enable firms to increase profits by decreasing initial prices and forgoing the adjustment costs, and by assumption initial prices cannot be lower than final prices. The precise details of the proof are provided in Harrington (2022a). We cover only the most relevant aspects here and leave it to the reader to verify that the extension to n firms does not create any applicability problems.

³⁶ The parallel in the case of conventional cartel theory is to look at the critical discount factor (usually depicted as δ^*) above which a reward–punishment strategy can stabilize a collusive outcome.

³⁷ To see that the first inequality holds, note that the terms within the square brackets of the numerator can be written as $Rb^2 + Sbd + Td^2$, where $R = 4(2n - 3)n^2$, $S = 4(2n - 3)n^2 - 2(n - 2)n$, and $T = (2n - 3)n^2 - 2(n - 2)n - 1$, which are all positive.

$$\frac{\partial \bar{g}}{\partial d} = \frac{2(a - bc)(n - 1)bd[4nb + (2n - 1)d]}{[4n^2b^2 + 2(2n - 1)abd + (n - 1)^2d^2]^2} > 0 \quad (8)$$

$$\frac{\partial \bar{g}}{\partial c} = \frac{-(n - 1)bd^2}{n[n^2(2b + d)^2 - 2nd(b + d) + d^2]} < 0 \quad (9)$$

$$\frac{\partial \bar{g}}{\partial b} = \frac{-(n - 1)d^2[cX + (a - bc)Y]}{n^2[4n^2b^2 + 2(2n - 1)abd + (n - 1)^2d^2]^2} < 0 \quad (10)$$

$$\frac{\partial \bar{g}}{\partial a} = \frac{(n - 1)d^2}{n[4n^2b^2 + 2(2n - 1)abd + (n - 1)^2d^2]} > 0 \quad (11)$$

where in (10) $X = n[4n^2b^2 + 2(2n - 1)abd + (n - 1)^2d^2]$ and $Y = n[8n^2b + 2(2n - 1)nd]$, which are both positive. The inequalities above follow from the fact that $\{a, b, d\} > 0$, $c \in [0, a/b)$, and $n \geq 2$. Taking the limits of \bar{g} shows that

$$\lim_{n \rightarrow \infty} \bar{g} = \lim_{d \rightarrow 0} \bar{g} = \lim_{c \rightarrow \bar{c}} \bar{g} = \lim_{b \rightarrow \bar{b}} \bar{g} = \lim_{a \rightarrow \underline{a}} \bar{g} = 0 \quad (12)$$

where $\bar{c} = a/b$ and $\bar{b} = a/c$ are the upper limits of the respective parameters and $\underline{a} = bc$ the lower limit. In other words, the scope for harm vanishes as these variables are taken to their extremes—including the obvious cases where there is no competition ($d = 0$) or no market ($c \geq a/b$). These results in turn provide for the following proposition on the scope for harm:

Proposition 1 (scope for harm): *There is less scope for anticompetitive effect when there are more firms, products are less substitutable, marginal cost is higher, the own-price sensitivity of demand is higher, or the demand intercept is lower—and there is no scope for harm in the limit cases, including those of infinitely many firms, unrelated goods, or high marginal cost.*

Interestingly, under both the present setup and conventional collusion theory there is less scope for anticompetitive effects when there are more firms and when products are less substitutable.³⁸ On the other hand, whereas the own-price elasticity of demand is conventionally taken not to have an impact on the scope for anticompetitive effects, here it reduces it.

³⁸ For a discussion of conventional collusion, see Ivaldi et al. (2003).

To illustrate the possible materiality of the above comparative result, we consider a number of numerical illustrations. We start by defining the benchmark case where $n = 2$, $a = 100$, $b = 1$, and $c = 10$ and vary respectively n , d , and c .³⁹ For expositional purposes, we transform the product substitutability parameter d such that $d = b\gamma/(1 - \gamma)$, with γ bounded between 0 (independent products) and 1 (perfect substitutes), and $\gamma = 0.9$ as benchmark. We also look at gross margin $(p^* - c)/p^*$ as opposed to the absolute marginal cost level. This is done by varying c numerically, calculating the corresponding margin and \bar{g} , and plotting the latter two against each other.

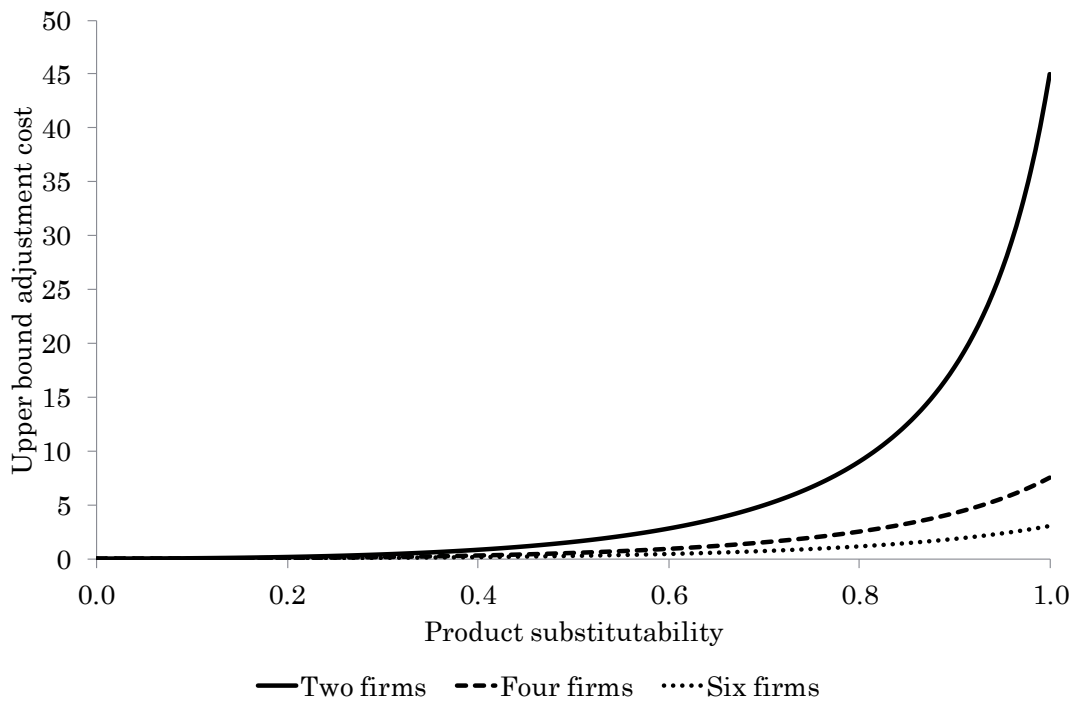
Figure 1 illustrates that the maximum price adjustment cost (i.e. upper bound \bar{g}) is materially lower when there are more firms involved and when products are less substitutable. In other words, the likelihood that the anticompetitive equilibrium exists depends crucially on there not being too many firms and products being sufficiently substitutable.⁴⁰

Figure 2 shows a similar picture when considering the comparative statics for gross margin $(p^* - c)/p^*$. With two firms and gross margins close to 100 percent, the maximum adjustment cost is relatively high. However, the latter can be significantly smaller when there are more firms and/or lower margins.

³⁹ This follows the numerical illustration by Harrington in Section 6 of his paper, although we take (as previously discussed) a different demand model specification and hence find different results.

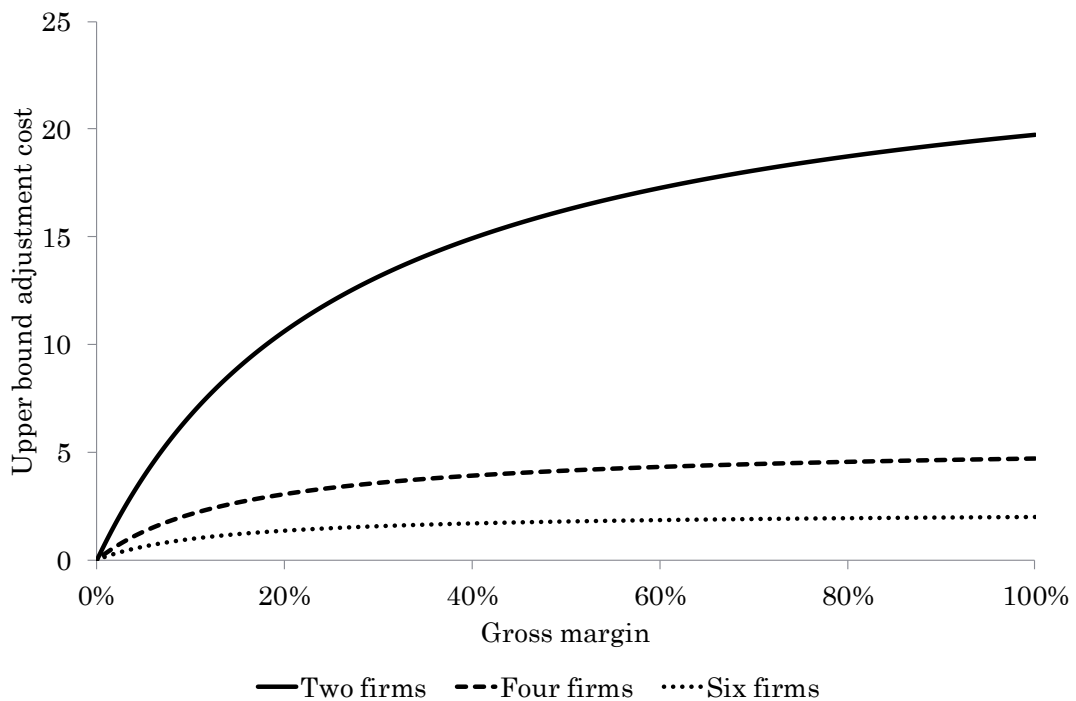
⁴⁰ Although this shows that the range within which the anticompetitive equilibrium exists may shrink considerably when there are more firms or products are less substitutable, this does not mean that this range is large or small in an absolute sense.

FIGURE 1. ADJUSTMENT COST RANGE AS FUNCTION OF SUBSTITUTABILITY



Note: This takes $a = 100$, $b = 1$, and $c = 10$, while varying γ and n .

FIGURE 2. ADJUSTMENT COST RANGE AS FUNCTION OF GROSS MARGIN



Note: This takes $a = 100$, $b = 1$, $\gamma = 0.9$, while varying gross margin $(p^* - c)/p^*$ and n .

2.3. Magnitude of harm

In the section above we considered the scope for harm, by evaluating the upper bound of the adjustment cost parameter g , above which the anticompetitive equilibrium does not exist. To analyze the comparative statics on the *magnitude* of harm, we express the overcharge under the anticompetitive equilibrium as a function of the variables of interest (adjustment cost, number of firms, product sustainability, and marginal cost). Following convention in damages litigation practice, we express the overcharge as a fraction of the anticompetitive price:

$$OC = \frac{p^* - p^c}{p^*} = \frac{gn^2}{an + gn^2 + [nb + (n - 1)d]c} \quad (13)$$

where p^c is the Nash equilibrium price in the absence of list price sharing—i.e. the competitive benchmark.⁴¹ In addition to the magnitude of harm as given by the overcharge, we also explore the link between the magnitude of harm and the scope for harm as given by the upper bound \bar{g} . We do so by looking at the overcharge that would occur at the upper bound—i.e. the upper bound overcharge.

The overcharge only occurs as long as $g \leq \bar{g}$, so the cost of adjusting prices should not be ‘too large’. Moreover, it follows readily from the expression above that the overcharge is lower (and hence the magnitude of harm lower) whenever the adjustment cost parameter is lower (assuming $g \leq \bar{g}$), i.e.

$$\frac{\partial OC}{\partial g} = \frac{(an + [nb + (n - 1)d]c)n^2}{(an + gn^2 + [nb + (n - 1)d]c)^2} > 0 \quad (14)$$

which holds given that $\{a, b, d\} > 0$, $c \in [0, a/b)$, and $n \geq 2$. The maximum overcharge thus obtains at $g = \bar{g}$. Similarly, we can derive the comparative statics for the number of firms, degree of product substitutability, marginal cost, own-price sensitivity to demand, and the demand intercept as

$$\frac{\partial OC}{\partial n} = \frac{(an + nbc + (n - 2)dc)ng}{(an + gn^2 + [nb + (n - 1)d]c)^2} > 0 \quad (15)$$

⁴¹ Note that p^c is simply p^* evaluated at $g = 0$. Our propositions on the comparative statics also hold when looking at the absolute overcharge, i.e. $p^* - p^c$, excluding the results on marginal cost and demand intercept, for which there is an effect on relative overcharge but no effect on absolute overcharge, as a and c then drop out of the overcharge expression.

$$\frac{\partial OC}{\partial d} = \frac{-gc(n-1)n^2}{(an + gn^2 + [nb + (n-1)d]c)^2} < 0 \quad (16)$$

$$\frac{\partial OC}{\partial c} = \frac{-g[nb + (n-1)d]n^2}{(an + gn^2 + [nb + (n-1)d]c)^2} < 0 \quad (17)$$

$$\frac{\partial OC}{\partial b} = \frac{-gn^3c}{(an + gn^2 + [nb + (n-1)d]c)^2} < 0 \quad (18)$$

$$\frac{\partial OC}{\partial a} = \frac{-gn^3}{(an + gn^2 + [nb + (n-1)d]c)^2} < 0 \quad (19)$$

which holds given that $\{a, b, d\} > 0$, $c \in [0, a/b)$, and $n \geq 2$ —where for conditions (16) and (18) we also take marginal cost to be strictly positive. Moreover, for all comparative statics apart from number of firms, we find that in the limit the overcharge disappears, i.e.

$$\lim_{g \rightarrow 0} OC = \lim_{d \rightarrow \infty} OC(c > 0) = \lim_{c \rightarrow \bar{c}} OC = \lim_{b \rightarrow \infty} OC(c > 0) = \lim_{a \rightarrow \infty} OC = 0 \quad (20)$$

with upper bound $\bar{c} = a/b$. These results provide for the following proposition.

Proposition 2 (magnitude of harm): *If the anticompetitive equilibrium exists, the associated overcharge is lower if the price adjustment cost or the number of firms are lower; or if the degree of product substitutability, marginal cost, own-price sensitivity of demand, or the demand intercept are higher—and no overcharge exists in the limit cases, including those of homogeneous goods, or high marginal cost.*

As with Proposition 1, there are parallels to conventional collusion, the magnitude of the effect in both cases being lower when there are fewer firms and a higher own-price elasticity. On the other hand, whereas product substitutability is conventionally taken to increase the magnitude of anticompetitive effects, here it decreases it.

Proposition 1 on the scope for harm and Proposition 2 on the magnitude of harm reveal an interesting tension in relation to some but not all parameters considered, as formulated in the following corollary.

Corollary: *While the scope for anticompetitive effect decreases with respect to the price adjustment cost, the number of firms, and the degree of product substitutability (and increases with respect to the demand intercept), the magnitude of harm is affected in the*

*opposite direction.*⁴² *On the other hand, the scope for and magnitude of harm are both lower when marginal cost or own-price sensitivity of demand are higher.*

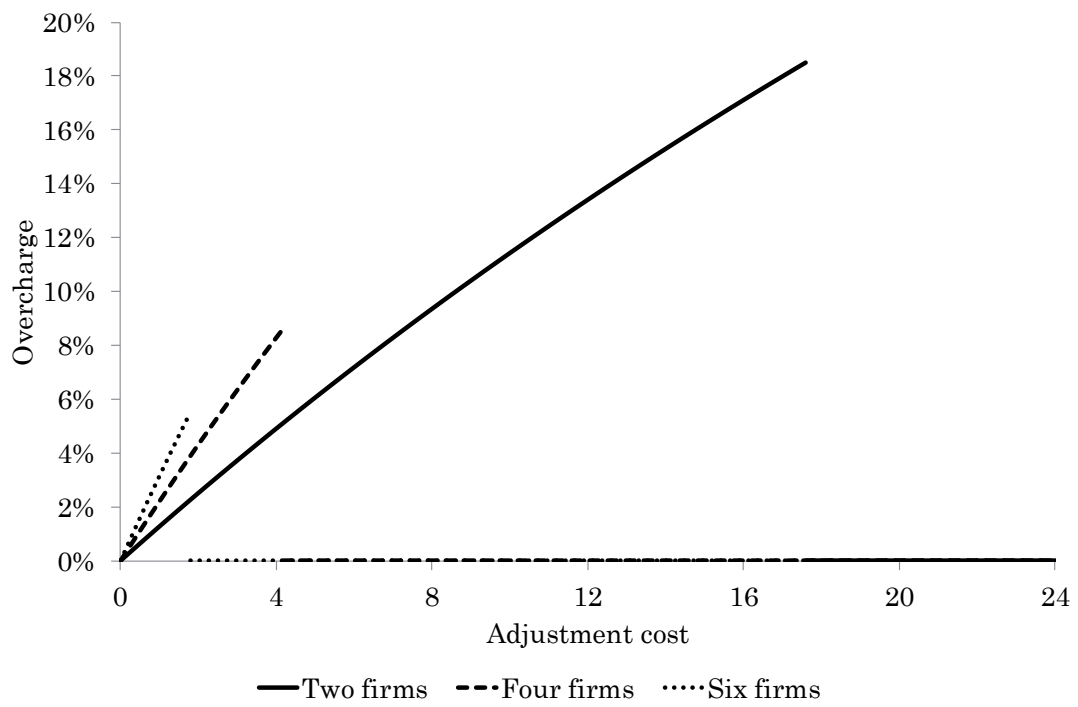
For the number of firms, the tension becomes clear when plotting the effect of the adjustment cost parameter on the overcharge, taking again the benchmark case where $a = 100$, $b = 1$, $\gamma = 0.9$, and $c = 10$, and varying the number of firms. This is shown in Figure 3, which shows that the overcharge increases in the number of firms—provided that the anticompetitive equilibrium exists—but also that the range within which there is an overcharge decreases (from 0–18.5% for $n = 2$ to only 0–5.5% for $n = 6$).

To see the tension between scope and magnitude in the case of product differentiation for the case where $a = 100$, $b = 1$, $c = 10$, and $g = 2$, first note that in Figure 4 an increase in product substitutability decreases the overcharge. Combining this with the opposite result on the upper bound of the adjustment cost parameter (as shown previously in Figure 1), the tension between scope and magnitude becomes clear when plotting the highest possible overcharge (i.e. the overcharge under the case where $g = \bar{g}$), while again assuming that $c > 0$. This is shown in Figure 5.⁴³ As product substitutability rises, so does the scope for harm given by \bar{g} , as illustrated in Figure 1. This is captured by a higher overcharge if g is set to equal \bar{g} (because the overcharge depends positively on g). On the other hand, the increase in product substitutability itself decreases the magnitude of the overcharge. For lower levels of product substitutability the first effect dominates, but this is reversed for higher levels of product substitutability. While not illustrated here, a similar tension can be shown for the demand intercept.

⁴² As regards price adjustment costs, even though these do not affect \bar{g} , the trade-off comes from the fact that higher price adjustment costs increase the overcharge but also move the parameter closer to the edge given by \bar{g} such that, if a conditional probability distribution were attached to the rest of the parameter space, a higher price adjustment cost g would indicate a lower probability of a higher overcharge, whereas a lower price adjustment cost would indicate a higher probability of a lower overcharge.

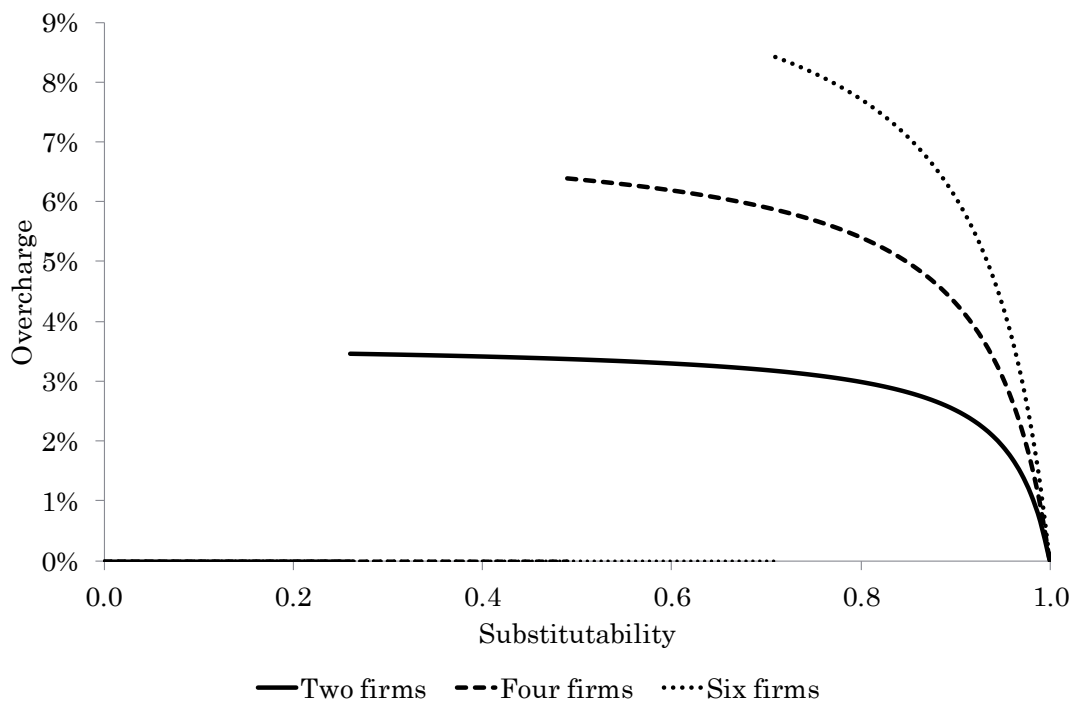
⁴³ Note that Figure 5 captures the same comparative statics analysis as Figure 2 in Harrington (2022a). However, Harrington's analysis shows an unambiguous increase in the (upper bound) overcharge when products become more similar. This appears to be a consequence of a linear demand specification that is not invariant to the degree of product substitutability under equivalent prices (unlike the Shubik-Levitan specification that we use)—see footnote 33.

FIGURE 3. OVERCHARGE AS FUNCTION OF ADJUSTMENT COST



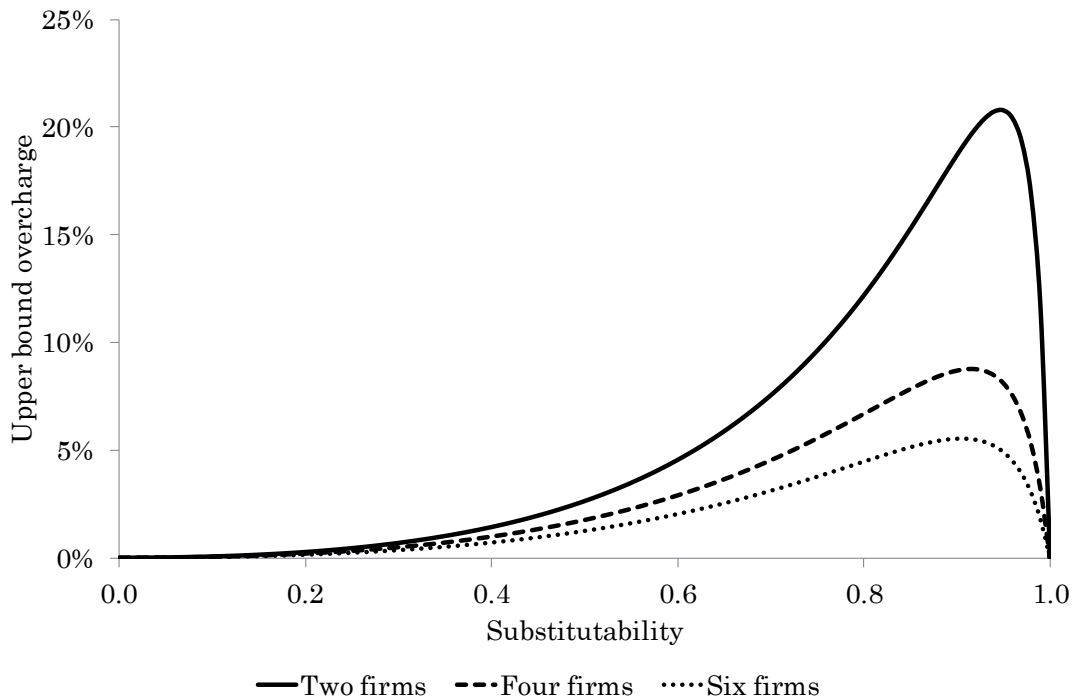
Note: This takes $a = 100$, $b = 1$, $\gamma = 0.9$ (which defines d), and $c = 10$, while varying n .

FIGURE 4. OVERCHARGE AS FUNCTION OF SUBSTITUTABILITY



Note: This takes $a = 100$, $b = 1$, $c = 10$, and $g = 2$ while varying γ and n .

FIGURE 5. UPPER BOUND OVERCHARGE AS FUNCTION OF SUBSTITUTABILITY



Note: This takes $a = 100$, $b = 1$, and $c = 10$, while varying γ and n . It also varies g to be at its highest, i.e. upper bound \bar{g} (above which the anticompetitive equilibrium does not exist).

3. Absence of an anticompetitive equilibrium under differentiated Cournot competition

We now show that if firms set quantities (or—with a view to Kreps and Scheinkman, 1983—capacity levels) instead of prices in this setup, there is no longer an anticompetitive equilibrium. In our analysis, we make a simplifying assumption analogous to that in Harrington (2022a), which is that any firm’s final quantity cannot be lower than its initial quantity (i.e. it can only deviate by increasing its output). In the current context this assumption could reflect the sunk nature of capacity costs.⁴⁴

A possible motivation for our setup is as follows. Suppose that firms set capacity levels with prices following capacity. If firms’ internal pricing processes rely on list prices, they may as a matter of industry practice disclose to each other their capacity levels and list prices to ensure that each firm’s list price is consistent with all players’ quantities (because in the Cournot context, each price is a function of all firms’ quantities). Following Harrington, we assume that once list prices are set, prices can be adjusted downward at a cost to give final prices. List prices are thus shared along with quantities to give a degree of commitment to the quantity information exchanged.

As in Harrington (2022a), the partial commitment entailed by sharing list prices gives rise to a dynamic game where final profits depend on both initial (i.e. list) and final prices. If no adjustment cost were attached to list prices, firms’ initial quantities would have no relevance. On the other hand, if prices could not be adjusted at all, there would be only initial quantities. In either case the game would collapse to the static single-stage version. As in Harrington, the question we consider is whether the two-stage dynamic introduced by list prices with partial commitment gives scope for a second, anticompetitive equilibrium.

In what follows we assume for convenience that list prices are automatically set to the price levels implied by both firms’ initial quantities, the latter being set by the firms simultaneously. The initial quantity of one firm then affects the list prices of both firms, not just its own list price.⁴⁵

⁴⁴ As in the case considered by Harrington, and as discussed below, this simplifying assumption is not expected to affect the result.

⁴⁵ Suppose instead that a change in one firm’s initial quantity will only change that firm’s list price (as, for example, when a firm makes a misleading capacity announcement but then sets its own list price in line with its real capacity). The effect of a firm setting a higher quantity than expected by its rival when the latter sets

The main result provided below is intuitive and driven by the strategic substitutability of quantities. This suggests that the below result generally holds when list prices are shared in the context of quantity competition and price adjustment costs, regardless of the precise assumptions used and the possible narratives that motivate them.

3.1. Model setup

The stages of the game are as follows. First, firms set their list prices, and second, firms set their (final) quantities by increasing them and, if they do, they incur a cost to the extent that final prices differ from list prices.

In the second stage firm i maximizes profits given by

$$\pi_i(q_i^F, q_j^F) - g[p_i^l - p_i^F(q_i^F, q_j^F)] \quad (21)$$

The resulting first-order condition is

$$\frac{\partial \pi_i}{\partial q_i^F} + g \frac{\partial p_i^F}{\partial q_i^F} = 0$$

where the second term gives the commitment effect of the list prices. As this is negative, the effect of price adjustment costs is to reduce output and raise prices, as in the Bertrand case.

Given symmetry, the same best-response function obtains for both players, which we denote by $\tilde{q}_i^{BR}(q_j)$.⁴⁶ Analogous to Harrington's p^* , we use q^* to denote the equilibrium quantity when both firms incur the price adjustment cost, given by the fixed point of $\tilde{q}_i^{BR}(\cdot)$.

It is straightforward to verify that Harrington's Theorem 2 on the existence of competitive subgame perfect equilibrium and its proof carry over *mutatis mutandis* to the Cournot case. It follows that there is a subgame perfect equilibrium in which both firms set the

its list price would then be to increase the rival's *total* price adjustment cost (because its list price will be higher than if it had known about the other firm's high capacity), but the rival's *marginal* price adjustment cost would be unaffected, so that the rival's behavior would not be altered. This assumption should therefore have no impact on our result as it does not affect firms' incentives to deviate from a low initial quantity.

⁴⁶ We keep the subscript i solely to avoid confusion as to which firm's best response is being contemplated at any given point of the analysis. We use the 'tilde' notation in $\tilde{q}_i^{BR}(q_j)$ to distinguish the best-response function in the presence of price adjustment costs from the simple best-response function $q_i^{BR}(q_j)$ in the absence of price adjustment costs.

competitive quantity in both stages. We now show that there is no additional ‘anticompetitive’ subgame perfect equilibrium.

3.2. Consideration 1: What if both firms set quantities equal to the second-stage anticompetitive equilibrium?

First, we proceed in parallel to Harrington to see if there is an anticompetitive equilibrium in which firms set q^* in both stages of the game.

If $q_i^l \leq q^*$ for both firms, then $q_i^F = q^*$ for both firms is the unique equilibrium in the second stage.

If $q_i^l > q^* \geq q_j^l$, then the unique equilibrium in the second stage is $q_i^F = q_i^l$ and $q_j^F = \max\{q_j^{BR}(q_i^l), q_j^l\} \leq q_j^l$. Note in particular that if $q_i^l = q^*$, then $q_j^F = q^*$ because $q_j^{BR}(q_i^l) < q^*$.⁴⁷

To check whether it is also an equilibrium in the first stage, we look at first-stage deviations from q^* by player i given that player j sets q^* in the first stage.

If firm i initially sets a lower quantity than q^* , q^* will still be the final quantity but firm i will needlessly incur price adjustment costs—so, analogous to Harrington, this is not a profitable deviation.⁴⁸ Note further that for the same reasons, the analogon of Harrington’s Lemma 1 holds here: in a subgame-perfect equilibrium, $q_i^l = q_i^F$ for both firms.⁴⁹

Now suppose that firm i sets a higher initial quantity $q_i^l > q^*$. Firm j will not respond to this by increasing its quantity from $q_j^l = q^*$, because that would imply that $\tilde{q}_j^{BR}(q_i)$ is an increasing function. Moreover, the simplifying assumption that $q_j^F \geq q_j^l$ ensures that firm j will not respond by decreasing its quantity either. It follows that firm j will keep its quantity at q^* , consistent with the above. However, this means that in the first stage firm i can profitably increase its initial quantity from q^* : the optimal way for it to do so is to maximize $\pi_i(q_i, q^*)$ with respect to q_i ; that is, to increase its initial quantity to the

⁴⁷ Given the Cournot setting, we assume that $\tilde{q}_j^{BR}(q_i)$ is a decreasing function. This means assuming that $\frac{\partial^2 \pi_i}{\partial q_i^F \partial q_i^E} + g \frac{\partial^2 p_i^F}{\partial q_i^F \partial q_i^E} < 0$. When demand is linear, the second term is zero so that the condition follows from the strategic substitutability of quantities in the standard differentiated Cournot setting.

⁴⁸ Note that in our setup, firm i increasing its quantity to q^* will cause price adjustment costs also for firm j . However, this does not change j ’s optimal response to q^* as it is akin to a change in p_i^l .

⁴⁹ Suppose to the contrary that $q_i^F > q_i^l$ and $q_j^F \geq q_j^l$, then $q_i^F = \tilde{q}_i^{BR}(q_j^F) > q_i^l$. But this means that there exists a positive ε such that $q_i^l + \varepsilon$ is still below $\tilde{q}_i^{BR}(q_j^F)$. Firm i can thus set a slightly higher initial quantity without affecting final quantities. Doing so reduces its price adjustment cost and is thus a profitable deviation.

competitive best response $q_i = q_i^{BR}(q^*) > q^*$ —given that this is a first-stage quantity increase, it involves no price adjustment costs. This shows that not only is there always a profitable first-stage deviation from q^* , but the optimal deviation points toward the competitive equilibrium, which is given by both firms setting initial quantities in line with the best-response function $q_i^{BR}(q_j)$. It follows that Harrington’s result for the Bertrand setup does not translate to the Cournot setup considered here.

We now show that no other anticompetitive outcome obtains in subgame perfect equilibrium either.

3.3. Consideration 2: What if both firms set quantities lower than the competitive level?

Denoting the competitive quantity by q^c , it turns out that, more generally, no quantity pair $\{q_i, q_j\}$ with $q_i < q^c$ and $q_j \leq q^c$ can obtain in a subgame-perfect equilibrium. For this to be an equilibrium, it is necessary that $\tilde{q}_i^{BR}(q_j) \leq q_i$, as otherwise firm i would have an incentive to deviate in the second stage by increasing its quantity to $\tilde{q}_i^{BR}(q_j)$. From this it follows that $\tilde{q}_i^{BR}(q^c) \leq q_i$. Now suppose that in the first stage firm j deviates by increasing its quantity to $q_j^{BR}(q_i^l)$. Then $q_j^l = q_j^{BR}(q_i^l) > q_j^{BR}(q^c) = q^c$, and then $\tilde{q}_i^{BR}(q_j^l) < \tilde{q}_i^{BR}(q^c) \leq q_i$, so i will not change its second-stage quantity in response (because it cannot decrease its quantity by assumption). But this means that the deviation has made firm j better off, by definition of $q_j^{BR}(q_i)$.

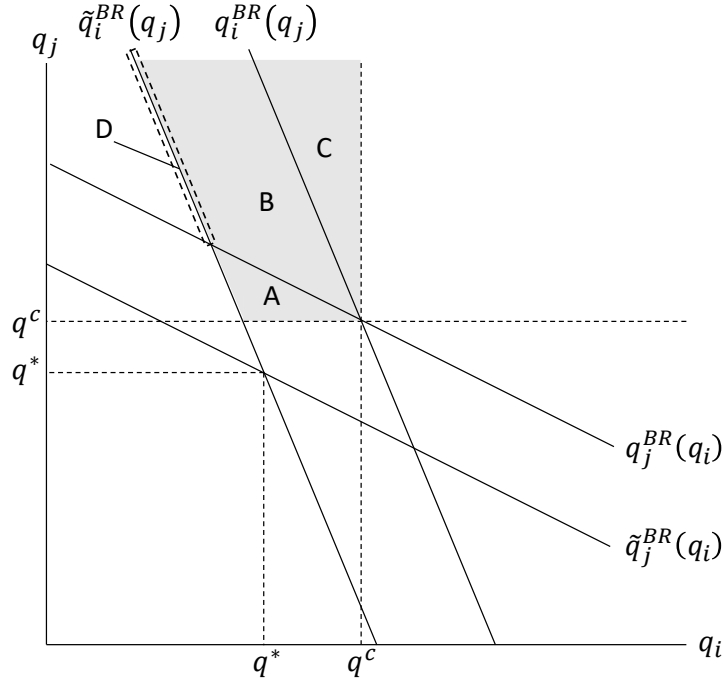
3.4. Consideration 3: What if one firm sets its quantity lower and one firm its quantity higher than the competitive level?

We now consider the possibility that there exists an equilibrium such that $q_i < q^c$ and $q_j > q^c$, as such an equilibrium may be anticompetitive. For $q_i < q^c$ and $q_j > q^c$ to be an equilibrium, it must further be the case that $\tilde{q}_i^{BR}(q_j) \leq q_i$ and $\tilde{q}_j^{BR}(q_i) \leq q_j$, as otherwise the firms would have an incentive to deviate by increasing their quantities in the second stage. Figure 6 illustrates the best-response functions as well as the area given by these four inequalities, which is shaded.

We can now show the absence of any anticompetitive equilibrium by considering all points within the shaded area. Suppose first that $q_j < q_j^{BR}(q_i)$, i.e. that we are in subarea A. Suppose that firm j deviates in the first stage by increasing its quantity to $q_j^{BR}(q_i)$, then the second-stage best response of firm i satisfies $\tilde{q}_i^{BR}(q_j^{BR}(q_i)) < \tilde{q}_i^{BR}(q_j) \leq q_i$. Given that firm i cannot lower its quantity, its best response is to keep its quantity at q_i . But then the first-stage deviation of firm j is profitable by definition of $q_j^{BR}(q_i)$.

Next suppose that $q_j = q_j^{BR}(q_i)$, i.e. that we are on the line that separates subarea A from subarea B. Note that this is strictly to the left of the line $q_i^{BR}(q_j)$ (because $q_i < q^c$), so $q_i < q_i^{BR}(q_j)$. If firm i deviates in the first stage by raising its quantity to $q_i^{BR}(q_j)$, then the second-stage best response of firm j satisfies $\tilde{q}_j^{BR}(q_i^{BR}(q_j)) < q_j^{BR}(q_i^{BR}(q_j)) < q_j^{BR}(q_i) = q_j$. Thus firm j responds by keeping its quantity at q_j , making the first-stage deviation of i profitable.

FIGURE 6. BEST-RESPONSE FUNCTIONS WITH/WITHOUT ADJUSTMENT COST



Note: The shaded area is defined by the inequalities $q_i < q^c$, $q_j > q^c$, $\tilde{q}_i^{BR}(q_j) \leq q_i$ and $\tilde{q}_j^{BR}(q_i) \leq q_j$, which all need to hold for an equilibrium of the type considered here.

That leaves the case $q_j > q_j^{BR}(q_i)$. Suppose first that $\tilde{q}_i^{BR}(q_j) < q_i$, i.e. that we are in subareas B or C but not on the portion of the line $\tilde{q}_i^{BR}(q_j)$ labeled D. This means that there exists $\varepsilon > 0$ such that $\tilde{q}_i^{BR}(q_j - \varepsilon) < q_i$ and $q_j - \varepsilon > q_j^{BR}(q_i)$, i.e. there exists a sufficiently small decrease of q_j such that the new quantity is still within subareas B or C. If firm j deviates to $q_j - \varepsilon$ in the first stage, then firm i will not change its quantity in response. Moreover, because q_j is above the best-response level $q_j^{BR}(q_i)$, a quantity decrease that is sufficiently small to not take the quantity below this best-response level, is profitable.

The only case left is the subcase of $q_j > q_j^{BR}(q_i)$ where $\tilde{q}_i^{BR}(q_j) = q_i$, i.e. the case given by the portion of the line $\tilde{q}_i^{BR}(q_j)$ labeled D. Now suppose that firm i deviates in the first

stage by increasing its quantity to $q_i^{BR}(q_j)$. Then the second-stage best response of firm j is $\tilde{q}_j^{BR}(q_i^{BR}(q_j)) < \tilde{q}_j^{BR}(q_i) < q_j^{BR}(q_i) < q_j$, so firm j will not change its quantity in response, making the deviation of firm i profitable.

It follows that there is no equilibrium in which $q_i < q^c$ and $q_j > q^c$. Essentially, within the shaded region, which does not include the competitive equilibrium, it is always possible for at least one of the firms to deviate to (or toward) its first-stage best response without taking the quantity pair outside the shaded region, and therefore without inducing a second-stage response by the other firm that might make such a deviation unprofitable.

To conclude, there are thus no subgame perfect equilibria in which one or both firms set their quantity below the competitive level, which proves the following proposition.

Proposition 3 (competitive equilibrium under Cournot): *Under symmetric differentiated Cournot competition there is a competitive subgame perfect equilibrium in which both firms set their quantities to the competitive level in both stages. There does not exist any (possibly anticompetitive) equilibrium in which one or both firms set a lower quantity than this competitive level.*

It may be objected that the result depends crucially—perhaps more so than in the Bertrand context—on the artificial simplifying assumption that firms cannot reduce quantity in the final stage. Note, however, that in the Bertrand setting, reducing initial price from the supracompetitive level is not a profitable deviation (under certain restrictions of the parameter space) because the rival will lower its final price in response. In the Cournot setting, the rival can be expected to respond to a higher initial quantity by decreasing its final quantity, which supports the profitability of the deviation. The fact that the result holds even if the rival is artificially assumed not to decrease its quantity is therefore a sign of robustness.

4. Further discussion

We have shown that—taking the model developed by Harrington—the anticompetitive equilibrium disappears when firms set capacity levels, with prices determined accordingly. Moreover, both the scope for and the magnitude of harm vary widely depending on the model parameters and often include zero scope or magnitude in the limit. This shows that the anticompetitive impact of a private information exchange of list prices is ultimately an empirical and/or factual question. There are a number of further

considerations regarding the narrative and model provided by Harrington that warrant discussion.

First, the theory proposed by Harrington abstracts from any ability and incentive for firms to adjust their internal pricing processes, possibly over time. Harrington simply assumes an exogenous adjustment cost parameter. However, firms would be unilaterally better off if this adjustment cost parameter were lower, as this would increase their internal pricing flexibility—essentially allowing them to cheat on the coordinated list prices by undermining their function as a commitment device. If there is scope for firms to reduce their price adjustment costs (perhaps over time), this undermines the proposed theory of harm.

Relatedly, as Harrington explicitly acknowledges, the model assumes that firms can verify the list prices that are exchanged, as firms otherwise have an incentive to set lower initial prices internally than the ones shared, so as to undercut competitors without incurring any adjustment cost. As verification may be difficult at the point of exchange (in particular if the information exchange is private), Harrington argues that the incentive compatibility problem could be resolved by extending the model to a conventional repeated-game framework on cartel stability that includes monitoring and the threat of retaliation (i.e. deterrence): if final customer prices are transparent, this may allow firms to monitor whether their rivals are setting their list prices in line with the information they exchanged.⁵⁰ However, as discussed above, the absence of effective monitoring and a credible threat of retaliation in certain cases (such as the EU trucks case) seems to be precisely what motivated the new theory in the first place.

Further, Harrington dismisses possible procompetitive or competitively neutral motivations for the exchange of list price information because he considers that these would also arise if prices were shared publicly rather than privately. For example, in his review of the literature he mentions papers that find that information exchanges involving initial or partial prices can be procompetitive because they allow for efficient price discovery.⁵¹ However, the fact that the procompetitive effects of a private

⁵⁰ A similar argument could be made in relation to endogenous price adjustment costs, discussed above. That is, firms could coordinate to keep their price adjustment costs high. In both cases the idea is that conventional coordination is used to solve the problem.

⁵¹ See Varian (1980), and Myatt and Ronayne (2019). Another potential efficiency is indicated by our discussion of the case of capacity constraints in Section 3 above. There the reason for exchanging list prices

information exchange are also achievable by other means does not mean that the private information exchange was not motivated by such effects. To provide an analogy: the fact that someone is using a driver's license to prove their age at the liquor store does not imply their intent to 'drive under the influence' just because the same objective could be achieved with an alternative ID such as a passport. The existence of a private information exchange therefore does not in itself imply that one is dealing with the part of the parameter space where there is an anticompetitive effect.

Moreover, also the theory of harm proposed by Harrington does not require prices to be exchanged privately (despite the fact that the theory is framed around the anticompetitiveness of a *private* information exchange of prices). In the event of a per se prohibition of private information exchange, the same anticompetitive effects could continue to materialize through public information exchange. In fact, the anticompetitive effects identified by Harrington would seem less likely in the case of a private list price exchange given that verifiability issues will generally be more likely than in the case of a public exchange. It is therefore not necessarily relevant that any benefits of private information exchanges might also be achievable through public information exchanges.⁵²

Moreover, there may be procompetitive reasons not just for exchanging list prices but for keeping them private. In the EU trucks case, for example, the fact that list prices have never been made public—even before the infringement period—might be indicative of this. For instance, private list prices may be an effective way of coordinating various divisions within a firm in relation to earlier, internal stages of price setting, during which a firm may not yet wish to make any sort of commitment vis-à-vis its customers regarding the prices that materialize during subsequent, external stages of the pricing process. If, in addition to keeping list prices private, there are also benefits to exchanging list price information with competitors (e.g. along the lines discussed above), then there would be a procompetitive feature specific to a *private* information exchange: namely that it would allow both the benefits of the information exchange and the benefits of list prices

was that such an exchange would help ensure that the list prices are meaningful. Moreover, list prices can be found in a number of competitive industries, which indicates that they are beneficial to the firms and that some of this benefit may be expected to reach consumers.

⁵² This is reminiscent of the 'indispensability criterion' of Article 101(3) TFEU, which requires that efficiency justifications for agreements that infringe Article 101(1) only be counted if the efficiency in question is unattainable by less restrictive means. In particular, for the reasons just discussed, public information exchanges need not be less restrictive than private ones in the present context. Of course, here we are not dealing with the question of efficiencies but with the prior question whether there was an infringement in the first place.

remaining private to materialize. A per se prohibition of private information exchange would then have detrimental effects on welfare as it would force a firm to either not exchange the information and thus forego the benefits associated with information exchange or to do so publicly and thus forego the benefits of keeping list prices private.

If all alternative explanations for why firms might engage in private list price exchanges are either competitively neutral or achievable also by more competitive means, an argument for a per se prohibition of *private* list price exchanges is that this would eliminate the risk of harm without eliminating any benefits: If the reason for the conduct is anticompetitive, eliminating it is beneficial; if the reason for the conduct is competitively neutral, eliminating it causes no harm; and if the reason for the conduct is procompetitive but achievable through other means, then eliminating it also causes no harm. Thus a per se prohibition would be justified if its effects are either beneficial or neutral but never detrimental. However, as noted above, firms might engage in list price exchanges for procompetitive reasons, in which case a per se prohibition may on balance be harmful. Moreover, given the novelty of Harrington's theory of harm, additional procompetitive reasons (theories of benefit) might be identified once scholars have had more time to engage with it. Deciding on a per se prohibition then requires a careful balancing of the theories of harm and the theories of benefit.

At any rate, even if a per se prohibition were considered justified because of the absence of procompetitive alternative explanations for a private exchange of list price information, this does not mean that there is also an economic justification for adopting a presumption of harm. The reason is that, even if any procompetitive effects could be realized some other way not involving the private exchange of list price information, such procompetitive (or, indeed, competitively neutral) effects might still be what motivated the conduct. In the case of a per se prohibition, this would amount to breaking the rules but not to creating any harm. To return to the liquor store example: there might be a requirement that the ID used to purchase alcohol be something other than a driver's license. If we assume that this does not entail any material inconvenience and therefore does not create any harm, such a requirement may be justified if it is generally effective at reducing driving under the influence of alcohol. If the liquor store nevertheless accepts a customer's driver's license as an ID, it might be punished for breaking the law, but it could not be deduced from this that the customer then actually did drive under the influence of alcohol.

5. Concluding remarks

The anticompetitive effect in Harrington (2022a) only arises in restricted parts of the parameter space of his model. As long as it is not shown that the anticompetitive rationale is the only rationale for a private exchange of list price information, the existence of such information sharing is not in itself sufficient to draw reliable conclusions about the presence of an anticompetitive effect. Given the novelty of the proposed theory and Harrington's call for a presumption of harm in relation to the conduct in question, we considered it important to explore the limitations of this theory.

We have shown that the anticompetitive outcome disappears in Harrington's model if firms are assumed to compete in quantities (or capacities) rather than prices. The reason is intuitive: a low initial quantity does not induce rivals to set low final quantities in the way that a high initial price can induce them to set high final prices. The low initial quantity in the Cournot context is thus not rewarded in the same way that a high initial price is in the Bertrand context. The difference comes from the fact that quantities are strategic substitutes, whereas prices are strategic complements.

We have further shown that there are a range of market features that can have a material impact on the scope for and magnitude of the anticompetitive effect, including the number of firms in the market, the degree of product substitutability, and the cost of adjusting list prices. This is just an initial list that future research is bound to expand.⁵³

Finally, we have discussed that Harrington's theory implicitly relies on a number of market features that may or may not be present in a given case, including the absence of firms' ability to adapt internal pricing processes over time, the verifiability of list price information, and the absence of possible procompetitive or competitively neutral explanations for the exchange of list price information.

In light of the above, we do not consider that a general presumption of harm would be justified in relation to private exchanges of list price information. Rather, it is our view that the competitive effects of private list price exchanges are best assessed on a case-by-case basis, for which the consideration of market features provided here should be informative. At what stage (of a competition law investigation and/or follow-on damages

⁵³ For example, for simplicity the analysis in Harrington (2022a) and in this article does not cover market asymmetries. It nevertheless seems plausible that asymmetries are capable of reducing the scope for anticompetitive harm by making it less likely that both firms have an incentive to set high list prices. The reason is that asymmetries are likely to increase the incentive to set a high list price for the one firm but decrease it for the other, causing the anticompetitive equilibrium to break down. The correctness of this intuition is left for future research to verify.

claims) and to what extent the specifics of the case are to be considered depends on the availability of the evidence as well as the clarity and nature of its implications, as this will determine whether the benefits outweigh the costs of a more case-specific assessment at any given stage of the process. In this regard the insights of the present article are hoped to be of use in determining what market features to consider and what their implications are for the competitive effects of the particular list price exchange at hand.

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