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Working Paper

Market transparency and competition policy

Working paper, No. 6-2001

Provided in Cooperation with:

Department of Economics, Copenhagen Business School (CBS)

Suggested Citation: Møllgaard, H. Peter; Overgaard, Per Baltzer (2001) : Market transparency and competition policy, Working paper, No. 6-2001, Copenhagen Business School (CBS), Department of Economics, Frederiksberg, <https://hdl.handle.net/10398/7567>

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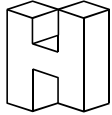
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Institut for Nationaløkonomi

Handelshøjskolen i København

Working paper 6-2001

MARKET TRANSPARENCY AND COMPETITION POLICY

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Market Transparency and Competition Policy*

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May 2001

Abstract

We survey some of the literature on the effects of improved market transparency on competition in oligopoly. Generally, improved transparency from the perspective of firms makes detection of deviations from tacitly collusive agreements easier, thus facilitating oligopolistic coordination. On the other hand, improved transparency from the perspective of consumers, particularly in terms of easier comparability of goods characteristics, has ambiguous effects: More elastic demands make deviations from collusive prices more profitable to firms in the short run, but they also make future retaliation by rivals more severe. Which of these forces will dominate in a dynamic oligopoly competition is shown to depend on the markets-specifics. In light of the theoretical results, we discuss the likely effects on inter-firm competition of information exchange and online trading institutions as well as the American and European competition policy attitude towards market transparency.

JEL: D18, D43, L13, L41

Keywords: market transparency, repeated oligopoly, secret price-cutting, customer switching.

*Without implicating anyone, we have benefitted from discussions of this and related work with S. Albæk, M. Hviid, S. Hylleberg, L. Lambertini, A. Nilsson and C. Schultz. We gratefully acknowledge financial support from the National Consumer Agency of Denmark.

”It is a wise district attorney who places the prisoners in separate interrogation rooms to foment uncertainty and distrust. Similarly, cooperation is much more likely to emerge in oligopoly pricing when rival managers keep one another informed of their plans and activities (if not in smoke-filled rooms, then through the business press) and when market transactions are sufficiently simple and frequent to be monitored easily.” (Scherer & Ross, 1990, p. 215)

1. Market Transparency: An Overview

Consumer advocates, (some) antitrust practitioners and the general public often hold that transparency of markets is an unqualified good. The advent of the Internet and online trading institutions has brought this view to the fore. However, in this paper we argue that improved market transparency can have several different interpretations, and that it is not always clear, or even probable, that it benefits competition or, ultimately, market efficiency.

The consumer protection view can be paraphrased roughly as follows. Improved market transparency enables consumers to compare substitute goods or services and their prices. Consequently, it should make consumers more sensitive to perceived differences in the mix of price and characteristics and, thus, intensify competition between rival suppliers. As a contrast, in a non-transparent market, rivals can free-ride on consumer ignorance, create artificial lock-in, and stifle price competition.

In fragmented search markets, improved transparency is likely to have positive effects: If only consumer search costs could be brought down, markets would function more efficiently. Hence, if improved market transparency is synonymous with decreased consumer search costs, then the consumer protection view is formalized in the existing literature. However, our focus here is on oligopolistic markets in which the scope for tacit collusion also varies with the information available to consumers and producers. This dynamic perspective is not readily captured by the existing literature on search markets, and it is certainly not captured by the consumer protection view as outlined above. Indeed, it seems hard to improve information to potential customers without at the same time affecting the information and/or strategic incentives of firms competing for those same customers. We argue that producers in oligopolistic markets could benefit from improved market transparency in at least two ways: *directly* or *indirectly*.

Direct benefits to oligopolists from improved information arise from the easier and/or speedier detection of deviations from a tacitly collusive agreement. This, of course, is part of the “folklore” of Industrial Organization. The seminal paper

by Stigler (1964) discusses the effects of secret price-cutting, detection lags, and lumpy orders on the scope for oligopolistic coordination. More recently, Ellison (1994) has studied the effects of secret price cutting in a famous 19th century railroad “cartel”.¹ These direct effects have immediate implications for the public policy response to information exchange between firms, rivals getting together at trade conventions, and the activities of trade associations, etc. In the age of the Internet, the activities of concern might occur in an industry-sponsored “chat room”.

Indirect benefits to oligopolists from improved information accrue from the possibility of making punishments following a deviation from collusive agreements more severe since consumers become more sensitive to perceived differences in the mix of price and characteristics across products. This aggravates the consequences of triggering a price war and, hence, might deter the deviation in the first place.

For expositional reasons, we find it useful below to distinguish between *price transparency* and *characteristics transparency* and discuss these separately (but within the same overall model). In the abstract, improved price transparency implies that prices are readily observed and with only a short delay. Improved characteristics transparency means that consumers can more easily compare substitutes with different characteristics. Making a market more transparent will thus be taken to mean that information to market participants improves along at least one of these two dimensions.

In the next section we outline a familiar model of dynamic oligopoly competition which may be used to study how the two types of market transparency – improved price information vs. improved information on product characteristics – affect the scope for tacit collusion in a fully specified game. Section 3 specifically studies the effects of improved price transparency focusing on its *direct* effect, while Section 4 analyses the effects of improved information flows on the consumer side and the *indirect* effect on firms alluded to above. In the latter section, we assume that firms are fully informed in the sense that they observe each others prices perfectly at the end of each period. Thus when we formally analyse the *direct* effect, we ignore the *indirect* effect and *vice versa*. An attempt is made to pull the two effects together in Section 5, where we comment on some practical policy concerns that arise from the interplay between market transparency and competition. We do this with particular reference to online trading institutions and information exchange. Section 6 contains a few concluding remarks.

¹For textbook treatments, see Tirole (1988, ch. 6), Scherer and Ross (1990, ch. 7-8), and Carlton and Perloff (1994, ch. 6-7).

2. A Model of Dynamic Oligopoly

In this section we set up a model which is largely a reinterpretation of a well-known and perfectly standard model from the oligopoly literature which is useful to illustrate the effects of the two types of transparency alluded to above.

To facilitate the exposition, the formal analysis is largely restricted to the duopoly case, while we comment on the general case with n firms only in passing.

2.1. Model outline

Following the exposition in Møllgaard and Overgaard (2001), let indirect demands be of the form

$$p_i = 1 - \frac{1}{1+\varphi}q_i - \frac{\varphi}{1+\varphi}q_j \quad i, j = 1, 2; i \neq j$$

This is just a specialized one-parameter version of the familiar set-up suggested by Spence (1976a), and further studied by Singh and Vives (1984) and Vives (1985),²

$$p_i = \alpha - \beta q_i - \gamma q_j \quad i, j = 1, 2; i \neq j \quad (2.1)$$

with $\alpha = 1$, $\beta = \frac{1}{1+\varphi}$, and $\gamma = \varphi\beta$, where $\varphi \in [0, 1)$. Note how this implies that $\beta + \gamma = 1$. This particular specialization implies that consumers display neither preference nor dis-preference for variety. This is to make sure that the consumer attitude to product variety will not flavour the potential outcomes of the oligopoly competition, since we want to focus exclusively on the various notions of market transparency. Of course, the form of indirect demands displayed above requires that the non-negativity constraints on individual firm quantities are not binding. However, these non-negativity constraints play an important role when deviations from tacitly collusive play and the possible punishment strategies are considered below. By inverting the demand system above, we can write the direct demands as³

$$q_i = 1 - \frac{1}{1-\varphi}p_i + \frac{\varphi}{1-\varphi}p_j \quad i, j = 1, 2 \quad (2.2)$$

²See also Spence (1976b). Variations on this basic set-up have been used by numerous authors to study a range of topics in oligopoly theory, see e.g. Dixit (1979), Friedman (1983), Tirole (1988, ch. 9), Albæk (1990), Martin (1993, ch. 2) and Carlton and Perloff (1994, ch. 8). For studies of repeated, differentiated oligopoly which rely on this modelling, see Deneckere (1983, 1984), Lambertini (1997), Albæk and Lambertini (1998), Lambertini and Schultz (1999) and Lambertini and Sasaki (1999).

³When in the following firms are indexed i and j , it is always understood that $i \neq j$.

Alternatively, we can write this as

$$q_i = 1 - p_i - \frac{\varphi}{1 - \varphi}(p_i - p_j)$$

The total industry demand as a function of the prices is

$$Q(p_1, p_2) = 2 - p_1 - p_2 \tag{2.3}$$

which, as a direct consequence of the consumer indifference towards product variety, is independent of φ . That is, for a fixed price vector, (p_1, p_2) , the total demand for the two goods is independent of φ .

Before continuing, we note a couple of features of demand, which will play a role in the analysis below. First, if $\varphi = 0$, then the demand for good i reduces to $q_i = 1 - p_i$, which is independent of p_j . Also, as $\varphi \rightarrow 1$, the demands become “infinitely sensitive” to price differences (i.e., the standard Bertrand-limit).

Closing the remaining loose ends, we assume that the firms set prices simultaneously in each period, that is, in each round of a repeated game. Further, we abstract from production costs, or, equivalently, assume that firms have CRS technologies with unit costs subsumed in $\alpha = 1$. Hence, in the remainder, the prices are to be interpreted as *net* of the unit costs. In the formal analysis, we allow prices in a particular period to be negative, which just implies that they can be below cost.⁴ The quantity produced or sold by each firm, of course, must be non-negative in every period.

2.2. Static equilibrium

By static equilibrium is simply meant the outcome of the market competition between the firms, if the market is only open a single period/instant. Firms are assumed to set prices simultaneously, and we look for a Nash Equilibrium of the one-shot game.

Ignoring (momentarily) the non-negativity constraints on individual quantities, the payoffs of firm i in a round of play as a function of the two prices and the parameter φ are given as

$$\pi_i(p_i; p_j, \varphi) = p_i \left(1 - \frac{1}{1 - \varphi} p_i + \frac{\varphi}{1 - \varphi} p_j \right) \tag{2.4}$$

⁴Below it is detailed how this plays a role when firms punish each other following a deviation. In actual life, there may, of course be a lower bound on prices, but we shall simply assume from now on that this never binds.

Thus, the best response of firm i to the price set by the rival, p_j , for a given value of the parameter φ , is

$$BR_i(p_j) = \frac{1-\varphi}{2} + \frac{\varphi}{2}p_j \quad (2.5)$$

It follows that the equilibrium prices of the one-shot, price-setting game are $(p_1, p_2) = (p_1^N, p_2^N)$, where

$$p_1^N = p_2^N = p^N = \frac{1-\varphi}{2-\varphi} \quad (2.6)$$

We observe the following features of the equilibrium strategies: $p^N \rightarrow 0$ as $\varphi \rightarrow 1$ and $p^N \rightarrow \frac{1}{2}$ as $\varphi \rightarrow 0$. Thus, as $\varphi \rightarrow 1$, the two products approach the limit of perfect substitutability in consumption, and the prices correspondingly approach the standard Bertrand or perfectly competitive limit (pricing at marginal costs). Also, as $\varphi \rightarrow 0$, the two goods cease to be substitutable in consumption, and the prices approach the monopoly limit (think of this as e.g. two “local monopolies”).

The static equilibrium profits are

$$\pi_1^N = \pi_2^N = \pi^N(\varphi) = \frac{1-\varphi}{(2-\varphi)^2} \quad (2.7)$$

where $\frac{\partial \pi^N(\varphi)}{\partial \varphi} < 0$, $\pi^N(\varphi) \rightarrow 0$ as $\varphi \rightarrow 1$ and $\pi^N(\varphi) \rightarrow \frac{1}{4}$ as $\varphi \rightarrow 0$.

2.3. Dynamic interaction and tacit collusion

We now consider an infinitely repeated version of the basic one-shot game analysed above. By this is meant that the two firms play the basic game over and over again with no foreseeable terminal date. Firms are assumed to discount future payoffs in the usual fashion, and we assume that firms have a common discount factor $\delta \in (0, 1)$. Initially, we consider an infinitely repeated game with (almost) perfect information, which means that prices become common knowledge at the end of the period in which they are set. But, before studying this game, we outline how colluding firms that set their prices jointly would behave in the one-shot game, and how an individual firm would respond in a one-period setting to a firm that unilaterally sets its collusive price.

2.3.1. Perfect collusion

Two colluding firms would set their prices jointly to solve

$$\max_{p_1, p_2} \{ \pi_1(p_1; p_2, \varphi) + \pi_2(p_2; p_1, \varphi) \} \quad (2.8)$$

Hence, the collusive price vector, (p_1^C, p_2^C) , solves

$$p_i = \frac{1-\varphi}{2} + \varphi p_j \quad i, j = 1, 2 \quad (2.9)$$

>From this, we immediately obtain

$$p_1^C = p_2^C = p^C = \frac{1}{2} \quad (2.10)$$

Thus, the collusive price-vector is independent of φ . Since consumers display no preference for variety, it follows that neither the collusive quantities nor the collusive payoffs depend on φ , and we have $(\pi_1^C, \pi_2^C) = (\frac{1}{4}, \frac{1}{4})$.

2.3.2. Best deviation

Suppose that a firm expects the other firm to set the collusive price derived above. What are the incentives of this firm, and how do they relate to the value of the parameter φ ? Specifically, we look at the incentives of firm 1 when it expects firm 2 to set the price $p_2 = \frac{1}{2}$. Thus, we consider the best response of firm 1 to $p_2 = \frac{1}{2}$.

We have already referred to the best response of an individual firm to the play of its rival competitor in (2.5). This was predicated on both firms being active at the resulting outcome (i.e., supplying strictly positive quantities to the market). However, it might be optimal for firm 1 to set a price which renders firm 2 inactive given that $p_2 = \frac{1}{2}$. This is certainly the case when $\varphi = 1$, which is just the standard Bertrand-limit: firm 1 has an incentive undercut firm 2's price "slightly", obtain all demand, and render firm 2 inactive. Quite generally, there will be kinks in firm 1's residual demand as a function of p_1 given p_2 , and this will be reflected in its best response. For a detailed discussion, see e.g. Deneckere (1983, 1984) and Lambertini and Albæk (1998).

The demands in (2.2) are predicated on $q_i > 0$, $i = 1, 2$. In contrast, firm 1's demand given $q_2 = 0$ is obtained from $p_1 = 1 - \frac{1}{1+\varphi}q_1$ as

$$q_1 = (1 + \varphi)(1 - p_1) \quad (2.11)$$

This is the demand facing firm 1, if $q_2 = 1 - \frac{1}{1-\varphi}p_2 + \frac{\varphi}{1-\varphi}p_1 \leq 0$, that is, if

$$p_1 \leq p_2 - \frac{1-\varphi}{\varphi}(1 - p_2) \quad (2.12)$$

On the other hand, given p_2 , q_1 drops to zero if $q_1 = 1 - \frac{1}{1-\varphi}p_1 + \frac{\varphi}{1-\varphi}p_2 \leq 0$; that is, if

$$p_1 \geq p_2 + (1 - \varphi)(1 - p_2) \quad (2.13)$$

In summary, the demand facing firm 1 as a function of p_1 given $p_2 = \frac{1}{2}$, is

$$q_1 = \begin{cases} 0 & \text{if } p_1 \geq \frac{1}{2} + \frac{1-\varphi}{2} \\ 1 - \frac{1}{1-\varphi}p_1 + \frac{\varphi}{2(1-\varphi)} & \text{if } \frac{1}{2} + \frac{1-\varphi}{2} \geq p_1 \geq \frac{1}{2} - \frac{1-\varphi}{2\varphi} \\ (1+\varphi)(1-p_1) & \text{if } \frac{1}{2} - \frac{1-\varphi}{2\varphi} \geq p_1 \end{cases} \quad (2.14)$$

Using this to define the payoff function of firm 1, it is immediately clear that $p_1 > \frac{1}{2} + \frac{1-\varphi}{2}$ could never be a best response, since pricing oneself out of the market is strictly dominated by some lower price. So, what remains is to compare optima on $[0, \frac{1}{2} - \frac{1-\varphi}{2\varphi}]$ and $[\frac{1}{2} - \frac{1-\varphi}{2\varphi}, \frac{1}{2} + \frac{1-\varphi}{2}]$. Let p^D denote the best response to (“the best deviation from”) the collusive price and define $\varphi^* \equiv (3)^{\frac{1}{2}} - 1 \simeq 0.73$. Then we can show that firm 1’s best response to $p_2 = \frac{1}{2}$ is given as (see Møllgaard & Overgaard (2001) or simply refer to Deneckere (1983, 1984) and Albæk and Lambertini (1998))

$$p^D = \begin{cases} \frac{1}{2} - \frac{\varphi}{4} & \text{if } \varphi \leq \varphi^* \\ \frac{1}{2} - \frac{1-\varphi}{2\varphi} & \text{if } \varphi \geq \varphi^* \end{cases} \quad (2.15)$$

We note the following features of the best deviation from collusive play: (1) p^D is continuous in φ , (2) $p^D < \frac{1}{2}$, $\forall \varphi \in (0, 1)$, (3) $p^D \rightarrow \frac{1}{2}$ (the standard Bertrand-limit) for $\varphi \rightarrow 1$, and $p^D \rightarrow \frac{1}{2}$ for $\varphi \rightarrow 0$. It follows that the best deviation is *non-monotonic* in φ . Finally, the best response by firm 1 to $p_2 = \frac{1}{2}$ renders firm 2 inactive if φ is sufficiently large ($\varphi \geq \varphi^*$), while firm 2 remains active if $\varphi < \varphi^*$.

The associated payoffs, $\pi^D(\varphi)$, which we shall refer to as deviation payoffs below, are

$$\pi^D(\varphi) = \begin{cases} \frac{(2-\varphi)^2}{16(1-\varphi)} & \text{if } \varphi \leq \varphi^* \\ \frac{(1+\varphi)(2\varphi-1)}{4\varphi^2} & \text{if } \varphi \geq \varphi^* \end{cases} \quad (2.16)$$

where $\pi^D(\varphi) \rightarrow \frac{1}{2}$ for $\varphi \rightarrow 1$ and $\pi^D(\varphi) \rightarrow \frac{1}{4}$ for $\varphi \rightarrow 0$. Furthermore, $\pi^D(\varphi)$ is continuous in φ , and $\frac{\partial \pi^D(\varphi)}{\partial \varphi} > 0$, $\forall \varphi \neq \varphi^*$. It follows that $\pi^D(\varphi)$ is monotonically increasing in φ .

2.3.3. The repeated game and tacit collusion

Generalities

Let us briefly abstract from the specific model outlined above since the main results for the repeated game can be explained quite generally without recourse to a fully specified stage-game. Consider a symmetric price-setting oligopoly with n firms, and let $\varphi \in [0, 1]$ be some measure of the substitutability of the products in consumption. If $\varphi = 0$, then the products are *non-substitutable* in consumption.

Effectively, this is the case of n “local monopolies”, since the demand facing a particular firm is completely unresponsive to the prices charged by the other firms. In contrast, if $\varphi = 1$, then the products are said to be *perfect substitutes*. In this case customers are “infinitely sensitive” to price differences as in the standard Bertrand-model. Suppose that for a given φ , the stage-game has a unique Nash Equilibrium with associated payoffs $\pi_1^N(\varphi) = \pi_2^N(\varphi) = \dots = \pi_n^N(\varphi) = \pi^N(\varphi)$. As in the specific example above, $\pi^N(\varphi)$ might naturally be assumed to be *strictly decreasing* in φ , capturing that static price competition intensifies as products become closer substitutes from the point of view of the consumers. If the firms were to collude perfectly in their price setting, then profits are $\pi_1^C(\varphi) = \pi_2^C(\varphi) = \dots = \pi_n^C(\varphi) = \pi^C(\varphi) > \pi^N(\varphi)$, $\forall \varphi > 0$. As in the example, we could assume $\pi^C(\varphi) = \pi^C$, i.e. collusive payoffs are *independent* of substitutability. Finally, on the assumption that the rivals all play the collusive price (assumed unique), there is a best response (deviation) of an individual firm giving rise to one-shot payoffs of $\pi^D(\varphi)$, where $\pi^D(\varphi) > \pi^C$, $\forall \varphi > 0$. Again, we might naturally assume that $\pi^D(\varphi)$ is *strictly increasing* in φ , capturing that the temptation to undercut a collusive agreement is increasing in the substitutability of the products in consumption.

With this notation, and on the additional assumption that the firms are restricted to simple Nash trigger-strategies in the repeated game, the main point can be stated as follows: Following a collusive path gives a firm discounted payoffs of

$$V^C = \frac{\pi^C}{1 - \delta}$$

whereas deviating gives

$$V^D = \pi^D(\varphi) + \frac{\delta \pi^N(\varphi)}{1 - \delta}$$

Roughly, the Nash trigger-strategies prescribe that firms start out by setting the collusive price and continue to set this price as long as all firms have charged the collusive price in the past. If a single firm ever strays from the collusive path, all firms charge the static equilibrium price from then on no matter what (that is, from the period following a deviation and forever after). For collusive pricing in every period to be sustainable requires

$$V^C = \frac{\pi^C}{1 - \delta} \geq \pi^D(\varphi) + \frac{\delta \pi^N(\varphi)}{1 - \delta} = V^D$$

which we can more conveniently write as

$$\delta \geq \delta(\varphi) \equiv \frac{T(\varphi)}{T(\varphi) + D(\varphi)} \tag{2.17}$$

where $D(\varphi) \equiv \pi^C - \pi^N(\varphi)$, (D is mnemonic for “deterrence”), and $T(\varphi) \equiv \pi^D(\varphi) - \pi^C$ (T is mnemonic for “temptation”).

To summarize the relationship between the required discount factor to sustain perfect collusion and the parameter φ , we can state that

$$\frac{d\delta(\varphi)}{d\varphi} \begin{matrix} \geq \\ \leq \end{matrix} 0 \text{ iff } \frac{dT(\varphi)/T(\varphi)}{d\varphi/\varphi} \begin{matrix} \geq \\ \leq \end{matrix} \frac{dD(\varphi)/D(\varphi)}{d\varphi/\varphi}$$

In other words, the required discount factor to sustain *full* collusion, $\delta(\varphi)$, is (locally) increasing (decreasing) in the measure of substitutability, if the temptation to cheat is more (less) sensitive to substitutability than the deterrence.

Specifics

To get some further insights, let us return to our specific example. As in the general case, a suitable version of (2.17) must be fulfilled for perfect collusion to be sustainable. In the specific model, the measure of deterrence reduces to

$$D(\varphi) = \pi^C - \pi^N(\varphi) = \frac{\varphi^2}{4(2-\varphi)^2} \quad (2.18)$$

and we note that

$$\frac{dD(\varphi)}{d\varphi} = \frac{\varphi}{(2-\varphi)^3} > 0, \forall \varphi \in (0, 1) \quad (2.19)$$

Hence, the gap between collusive and static equilibrium payoffs widens as products become closer substitutes in consumption. Similarly, the measure of temptation is given as

$$T(\varphi) = \pi^D(\varphi) - \pi^C = \begin{cases} \frac{\varphi^2}{16(1-\varphi)} & \text{if } \varphi \leq \varphi^* \\ \frac{\varphi^2 + \varphi - 1}{4\varphi^2} & \text{if } \varphi \geq \varphi^* \end{cases} \quad (2.20)$$

and

$$\frac{dT(\varphi)}{d\varphi} = \begin{cases} \frac{\varphi(2-\varphi)}{16(1-\varphi)^2} > 0 & \text{if } \varphi \in [0, \varphi^*) \\ \frac{2-\varphi}{4\varphi^3} > 0 & \text{if } \varphi \in (\varphi^*, 1) \end{cases} \quad (2.21)$$

Thus, the gap between deviation payoffs and collusive payoffs is monotonically increasing in the substitutability of the products in consumption. The critical discount factor for sustaining perfect collusion,

$$\delta(\varphi) \equiv \frac{T(\varphi)}{T(\varphi) + D(\varphi)}$$

is continuous in φ and differentiable except at $\varphi = \varphi^*$. Define $\varphi^{**} \equiv \frac{2}{3}((10)^{\frac{1}{2}} - 2) \simeq 0.77 > \varphi^*$. Then we can state the following result on the relationship between the required discount factor and the degree of substitutability.

Proposition 1. $\delta(\varphi)$ is strictly increasing in φ on $[0, \varphi^{**})$, attains a maximum at $\varphi = \varphi^{**}$, and is strictly decreasing in φ on $(\varphi^{**}, 1)$.

Proof. See Møllgaard and Overgaard (2001). ■

We note that $\delta(\varphi) \rightarrow \frac{1}{2}$ for $\varphi \rightarrow 0$, $\delta(\varphi) \rightarrow \frac{1}{2}$ for $\varphi \rightarrow 1$, and $\delta(\varphi) > \frac{1}{2}$ for all $\varphi \in (0, 1)$. In particular, the required discount factor is maximized at $\varphi = \varphi^{**} \simeq 0.77$ and $\delta(\varphi^{**}) \simeq 0.61$.

2.3.4. Partial collusion

If full collusion is not sustainable by Nash triggers, the alternative is not necessarily a return to the non-cooperative Bertrand-Nash prices and profits. Rather, if the discount factor $\delta < \delta(\varphi)$, the rivals may reduce the collusive price until the incentive to deviate is eliminated. In the following we focus on the maximal, symmetric price that is sustainable by Nash triggers. Thus we examine the properties of this “partially collusive” price $p \in [p^N, p^C]$. The incentive constraint may be written as

$$\frac{1}{1-\delta}(1-p)p \geq \begin{cases} \frac{1}{4}(1-\varphi) \left[1 + \frac{\varphi}{1-\varphi}p\right]^2 + \frac{\delta}{1-\delta}\pi^N(\varphi) & \text{if } \varphi \leq \varphi(p) \\ \frac{1+\varphi}{\varphi}(1-p) \left[p - \frac{1-\varphi}{\varphi}(1-p)\right] + \frac{\delta}{1-\delta}\pi^N(\varphi) & \text{if } \varphi \geq \varphi(p) \end{cases} \quad (2.22)$$

where $\varphi(p)$ is defined as the borderline between the case where a best reply to p would cause the rival to be inactive and the case where he would still be active. It is easily shown that

$$\varphi(p) = \frac{-1 + \sqrt{1 + 9(1-p)^2}}{2(1-p)}$$

is a decreasing function of p taking its (constrained) maximum⁵ at $p^N(\varphi)$ and a minimum at $p = p^C = \frac{1}{2}$ where $\varphi(p^C) = \varphi^*$.

Denote the maximal price that satisfies (2.22) by p^{PC} . Tedious algebra reveals that when $\varphi \leq \varphi(p)$, p^{PC} is a decreasing function of φ and an increasing function of δ . This is also the case when $\varphi \geq \varphi(p)$ as long as $\delta \leq \frac{1}{2}$. However, for $\varphi \geq \varphi(p)$ and $\delta \in (\frac{1}{2}, \delta(\varphi))$, p^{PC} is decreasing in φ up to some limit $\varphi(\delta)$ and then increasing in φ . The function $\varphi(\delta)$ defies any intelligible expression but is decreasing in δ .

As an example consider the case of $\delta = 0.53$. The slender curve shows $\varphi(p)$, while the fat curve illustrates p^{PC} as a function of φ . The horizontal line is $p^C = \frac{1}{2}$. p^{PC} is decreasing until $\varphi \simeq 0.897$ and then increasing until $\varphi \simeq 0.958401$.

⁵The “unconstrained” maximum is $\varphi(0) = 1$.

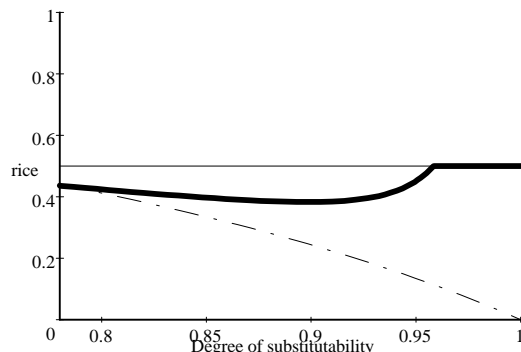


Figure 1: Maximal sustainable symmetric price ($\delta = 0.53$)

In sum: The maximal sustainable, partially collusive price, p^{PC} , is a function of the degree of substitutability, φ , and of the discount factor, δ . It is always increasing in δ . For low φ and δ , p^{PC} is decreasing in φ but for relatively high values of the discount factor and high substitutability in demand, an increase in substitutability may lead to an increase in prices! We exploit and explain these results in sections 3.3 and 4.2.2 below.

This ends our outline of the basic underlying model of the repeated oligopoly competition. Below we argue that variations on this set-up provide a useful background against which to discuss varying degrees and forms of market transparency.

3. Detection Lags and Uncertain Detection

This section shows how very simple reinterpretations of what is going on in the basic repeated game described in the previous section allow us to capture both detection lags and cases where deviations are only observed with a certain probability. Detection lags and uncertain detection are alternative ways of modelling what has loosely been referred to as secret price cutting. A detection lag means that a deviation (i.e., a price cut) can be kept secret for a while, while a probability of detection less than one implies that the deviation may never be detected at all. For completeness, we note that lumpy and infrequent orders will have roughly the same effect as a detection lag, since this is comparable to assuming that the next round of play is far into the future. On this Tirole (1988, p. 248) remarks that

“The threat of a punishment operates only if the punishment comes fairly soon after a price cut. Punishment might be delayed for two re-

lated reasons. First, a firm's price cut may be learned of by its rival only with a lag. This may happen when manufacturers contract with a few big buyers (wholesalers or downstream manufacturers). The secrecy of contracts may then be an obstacle to collusion. Indeed, if price cuts were never detected, collusion could not be sustained. Second, infrequent interaction (due to lumpiness in orders, for instance) delays the punishment and makes current price cutting more attractive."

Most of what we have to say in this section does not require a fully worked out example, but towards the end we do rely on a fully specified model.

3.1. Detection lags

Now, consider a repeated game with a detection lag. To set the scene, let us briefly explain exactly what we mean by a detection lag in repeated oligopoly. Saying that there is a detection lag of τ is tantamount to assuming that deviations from a tacit agreement is observed by a firm's rivals with a lag of τ rounds of play or periods. That is, if a firm deviates in period t this will be detected by the rivals at the end of period $t + \tau$, and punishments can start in period $t + \tau + 1$. With this notational convention, in a standard oligopoly model without detection lag ($\tau = 0$), the deviation is detected at the end of period t , and the punishment can start in period $t + 1$. This, of course, is just the model analysed above.

For comparison with the analysis above, we again consider whether firms are able to collude perfectly on the "monopoly price" p^C with resulting profits in every period π^C . Firms are restricted to Nash trigger-strategies. By following the collusive path a firm obtains

$$V^C = \frac{1}{1 - \delta} \pi^C$$

By deviating until detected, the firm obtains

$$V^D = (1 + \delta + \delta^2 + \dots + \delta^\tau) \pi^D(\varphi) + \delta^{\tau+1} (1 + \delta + \delta^2 + \dots) \pi^N(\varphi)$$

That is, by deviating a firm receives the deviation payoffs for $\tau + 1$ periods, after which the period payoffs coincide with the static Nash Equilibrium payoffs forever. The discounted value of this stream of payoffs can be rewritten as

$$V^D = \frac{1}{1 - \delta} \pi^D(\varphi) - \frac{\delta^{\tau+1}}{1 - \delta} (\pi^D(\varphi) - \pi^N(\varphi))$$

Hence, to sustain perfect collusion, we require

$$V^C = \frac{1}{1 - \delta} \pi^C \geq \frac{1}{1 - \delta} \pi^D(\varphi) - \frac{\delta^{\tau+1}}{1 - \delta} (\pi^D(\varphi) - \pi^N(\varphi)) = V^D$$

In the notation introduced above, we can write this as

$$\delta^{\tau+1} \geq \frac{T(\varphi)}{T(\varphi) + D(\varphi)}$$

or

$$\delta \geq \delta(\tau) = \frac{\tau+1\sqrt{T(\varphi)}}{\tau+1\sqrt{T(\varphi) + D(\varphi)}}$$

>From this it is immediately clear, and not very surprising, that the required discount factor is increasing in the detection lag, that is, the delay before rivals detect a deviation and start responding. So, absence of transparency, interpreted as long detection lags or lumpy orders, is good from the perspective of antitrust, in the sense that it makes tacit collusion harder to sustain.

3.2. Uncertain detection

Next, consider a repeated game where deviations are only observed with a certain probability. To capture this idea as simply as possible, let us assume that a deviation from a tacit agreement is only detected with a probability $\omega \in [0, 1]$. If a deviation is detected, then it is detected immediately. So, the standard model is simply one where $\omega = 1$.

Again, we study the scope for sustaining perfect collusion on the monopoly price. A firm that follows the collusive path obtains

$$V^C = \frac{1}{1 - \delta} \pi^C$$

while a firm contemplating a deviation (once and then return to the prescribed strategies⁶) expects to obtain

$$V^D = \pi^D(\varphi) + \delta \left(\frac{\omega}{1 - \delta} \pi^N(\varphi) + (1 - \omega) V^C \right)$$

So, perfect collusion requires

$$V^C = \frac{1}{1 - \delta} \pi^C \geq \pi^D(\varphi) + \frac{\delta}{1 - \delta} (\omega \pi^N(\varphi) + (1 - \omega) \pi^C) = V^D \quad (3.1)$$

We can rewrite this as

$$\delta \geq \frac{\pi^D(\varphi) - \pi^C}{\pi^D(\varphi) - \pi^C + \omega(\pi^C - \pi^N(\varphi))}$$

⁶Formally, this is, of course, equivalent to deviating in every period until detected.

Or, in the notation introduced above

$$\delta \geq \delta(\omega) \equiv \frac{T(\varphi)}{T(\varphi) + \omega D(\varphi)}$$

from which it is immediately obvious that the required discount factor is decreasing in the probability of detection. Again, absence of transparency, interpreted as low probabilities of detection of price cuts, is good from the perspective of antitrust, for the same reason as long detection lags.

Models with detection lags and uncertain detection can be combined. But there is little reason to do so, from the perspective of the present paper, since the results would follow immediately from the two models considered above.

3.3. Maximum sustainable price

If the discount factor is below $\delta(\tau)$, perfect collusion is not sustainable at the current detection lag, so the firms may collude on a lower price $p^{PC}(\delta, \varphi, \tau)$. It follows from the discussion of section 2.3.4 that this price is always decreasing in τ . There we argued that the maximal, symmetric price sustainable by Nash triggers is increasing in the discount factor, and a longer detection lag corresponds to a lowering of the discount factor. Thus, when full collusion cannot be sustained, an increase of transparency that shortens the detection lag may lead to an increase of the price.

In the case of uncertain detection, the incentive constraint of partial collusion (2.22) needs to be modified along the lines of (3.1). Again two cases obtain: One in which the static best response to the partially collusive price $p^{PC}(\delta, \varphi, \omega)$ would be a price at which the rival was active, and one in which this was not the case. In both cases, the maximal sustainable price is increasing in the probability in detection, but the qualitative way in which it increases differs. Figure 2 illustrates that for a discount factor of $\delta = 0.7$, full collusion cannot be sustained when the probability of detection is low. So, the rivals have to settle for a lower, partially collusive price. How low they go also depends on the degree of substitutability, φ : The left-most curve is valid for $\varphi = 0.5$, the middle curve for $\varphi = 0.6$ and the right-most, fat curve for $\varphi = 0.7$.

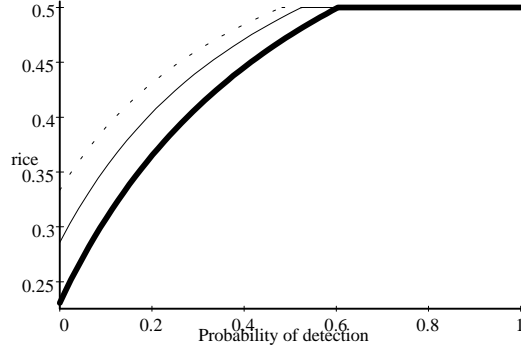


Figure 2: p^{PC} as a function of the probability of detection ($\delta = 0.7$)

Observe that the detection probability for which full collusion can be sustained is increasing in φ , so that higher substitutability requires a higher detection probability for full collusion to be sustained. On the other hand, given a certain low detection probability, $p^{PC}(\delta, \varphi, \omega)$ is decreasing in φ . This mirrors results in section 2.3.4 and will be used again in section 4.2.2.

The other case, when the static best response to $p^{PC}(\delta, \varphi, \omega)$ would render the rival inactive, only happens for relatively high φ and relatively high values of δ . It is relatively easily shown that for all relevant values of δ and φ , $p^{PC}(\delta, \varphi, \omega)$ is increasing in ω also in this case. Figure 3 shows $p^{PC}(0.53, \varphi, \omega)$ for three values of φ : 0.9 (dotted), 0.95 (slender) and 0.958401 (fat). The discount rate of 0.53 was chosen for comparability with Fig. 1.

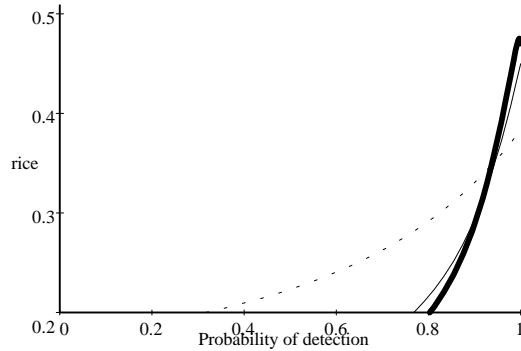


Figure 3: p^{PC} as a function of the probability of detection ($\delta = 0.53$).

Note that the higher is φ , the more rapid is the increase in the partially collusive price for a given change in the detection probability. On the other hand,

for a given detection probability ω , the higher φ is, the lower is p^{PC} , but only up to a point (roughly 0.9 in Fig. 2): For high values of the detection probability, an increase in φ would cause the partially collusive price to go up! This mirrors the result of section 2.3.4 and we shall exploit this further in section 4.2.2.

In sum: The maximal sustainable partially collusive price is a function of the discount factor, the degree of substitutability, the detection lag and/or the detection probability. If an increase in transparency leads to a shortening of the detection lag and/or an increase in the probability of detection, then the price may go up as a result! These are examples of the *direct* effects of improved transparency: the threat of a sooner or more likely punishment disciplines oligopolistic coordination.

4. Improved Product Comparability

As suggested in the previous section, the literature on the interaction between information and the scope for tacit collusion has focused mainly on information exchange between firms, that is, on the *direct* effect on competition. Next, we want to focus on the *indirect* effect. To do that we shall interpret improved market transparency on the consumer side as increased comparability of the *quality* or *characteristics* of goods and services (insurance policies provide a good example). In this setting it turns out that market transparency may be a mixed blessing from the point of view of competition and market efficiency in a dynamic oligopoly. Based on a slight reinterpretation of the basic model in Section 2, we argue that improved transparency can affect the scope for collusion in an ambiguous way. On the one hand, improved transparency may well make consumers switch more easily from one supplier to another. In the language of Section 2, this has the effect of increasing the (static) temptation of individual firms to deviate from tacitly agreed high prices. *But*, on the other hand, the possible future punishment becomes more severe (hence, the deterrence is also increasing in transparency). If the objective of consumer protection and antitrust policy is to make tacit collusion as difficult to sustain as possible, we find that the “optimal degree of transparency” may not be perfect transparency, *unless* the oligopolists may rely on sophisticated, optimal punishment strategies. When full collusion is impossible in equilibrium, we show how the maximum sustainable price is related to a measure of transparency. Also, for a “small” number of firms, the optimal degree of transparency is increasing in the number of firms, while if the number of firms is “sufficiently large”, perfect transparency is optimal.⁷

⁷ *Optimality* is defined with respect to the (admittedly, limited) objective of making horizontal collusion as difficult as possible. Of course, this objective is derived from some higher-order

While most of the literature is related to the direct effect, there are a few exceptions such as Nilsson (1999) and Schultz (2001). Nilsson (1999) employs an adapted version of the *price*-search models of Burdett and Judd (1983) and Fershtman and Fishman (1992)⁸ to show how a decrease in search costs shifts the price distribution down in a *static* setting,⁹ whereas the relationship between search costs and the scope for tacit collusion is ambiguous in a *dynamic* setting. If decreases in search costs are interpreted as the results of increased efforts by government agencies to improve market transparency from the point of view of consumers,¹⁰ then the relationship between this effort and the scope for duopoly-collusion may be ambiguous/non-monotone. The critical trade-off resembles the one above: the static incentive to undercut increases, while the possible punishments become more severe as search costs are brought down. However, there are significant conceptual differences between Nilsson’s approach and our. In Nilsson’s model consumers are assumed to know that goods offered by different outlets are identical, while sampling an extra price quote is costly. In our model, consumers observe prices for free but are uncertain about the substitutability of goods available from different outlets. Hence, Nilsson’s study should be interpreted as a model of *price* transparency, whereas transparency below refers to *product characteristics*. In this sense, the two studies complement each other.

Relatedly, Schultz (2001) considers *price*-transparency in a repeated Hotelling-style model of price competition, where some consumers are informed about a given firm’s price while others are not. In this setting, the fraction of potential customers who are informed about the prices at one or both outlets can be (suitably) interpreted as a measure of market transparency. Thus, in a transparent market, many consumers are informed and individual firm demands are highly elastic. With highly elastic demands, static pricing is highly competitive. On the other hand, with highly elastic period-demands, punishments also become more severe, and it follows that there is a trade-off between two effects. In the particular modelling of Schultz (2001) this trade-off is always resolved in

concern for efficiency or consumer welfare.

⁸A continuum of consumers with unit demands and identical reserve prices are served by two price-setting firms with homogenous goods. Some consumers have zero search costs, while others have strictly positive search costs. All consumers observe one price for free and may decide to search for the other.

⁹The static Nash equilibrium is in mixed strategies. Thus, heuristically, the “average” price charged in the static equilibrium is decreasing in transparency. In this sense, the static price competition becomes more intensive as the market becomes more transparent from the point of view of consumers.

¹⁰Here, we would argue that this is what many (casual) commentators have in mind when they call for government-sponsored web-sites that allow comparison shopping for e.g. insurance and credit products.

favour of price-transparency: collusion is more difficult the more transparent is the market, and the maximal sustainable price is non-increasing in the measure of transparency. In the sense that Schultz’s model is about price transparency this complements the results below. However, the unambiguous resolution of the trade-off in favour of transparency is in contrast to the results below.

4.1. Transparency and product characteristics

We want to argue that the basic oligopoly model presented in Section 2 can be reinterpreted in such a way that it constitutes a useful background against which to discuss transparency relating to *product characteristics*.¹¹ Based on the results obtained for this model we show how market transparency and the scope for collusion are related. But before doing so, let us fix ideas.

We first study the infinitely repeated *duopoly* game with discounting and then briefly comment on the general case with n firms. First, to discuss characteristics transparency, the stage-game could be entirely standard, except that we want to relate the demand facing each firm to some meaningful notion of market transparency. Secondly, to simplify the exposition, if the market is fully transparent, the game should reduce to a standard homogenous goods Bertrand-game. Thirdly, if the market is less than fully transparent, the goods offered for sale are perceived by potential customers to be differentiated in the relevant product space, although they are, in fact, intrinsically homogeneous.¹² Finally, if the market is “completely non-transparent”, then demands are independent, and we effectively have (“local”) monopolies each serving a fraction of consumers. Let θ be the measure of market transparency. Then, for the duopoly case, the model should capture that the demand facing firm i , $q_i(p_i; p_j, \theta)$, becomes more sensitive to price differences, $|p_i - p_j|$, as θ increases.

Let us return to the basic model in Section 2. In (2.2) substitute θ for φ to obtain

$$q_i = 1 - \frac{1}{1 - \theta} p_i + \frac{\theta}{1 - \theta} p_j \quad i, j = 1, 2$$

where θ is the measure of transparency. We note that this demand facing firm i has all the features alluded to above. If the market is completely non-transparent ($\theta = 0$), demand reduces to $q_i = 1 - p_i$, which is independent of the price set by

¹¹In this and the following subsections, we borrow heavily from the work presented in Møllgaard and Overgaard (2001). Here, we shall leave out many of the formal details.

¹²That they are intrinsically homogeneous is unimportant (but convenient) for our arguments: The important thing is that increased transparency means that customers are better informed about the true relative quality of the goods provided by different suppliers.

the rival. As the market becomes fully transparent ($\theta \rightarrow 1$), demand becomes “infinitely sensitive” to price differences as in the standard Bertrand-model. Heuristically, the demands capture that as the market becomes more transparent, the consumers perceive the two goods as closer substitutes. This seems to capture what consumer protectionists have in mind when they argue that lack of market transparency from the perspective of consumers creates “artificial” product differentiation and leads to a dampening of price competition. So, if only transparency could be increased, then price competition would be more intensive to the benefit of consumers (and society at large).

Consumers may be imperfectly informed due to transaction costs. Hadfield, Howse and Trebilcock (1998) note that reading and interpreting the terms of a contract is costly and that the likelihood that the contract contains the relevant terms may be too small to merit a careful contract review. Contract law has partly responded to this by requiring that sellers put onerous terms in plain language and draw consumer attention to them, if they wish to rely on such terms.¹³ These requirements correspond to increasing our measure of transparency, θ . We show that in dynamic, oligopolistic markets such an increase in transparency may be of dubious value to consumers.

On a similar note Thorelli and Thorelli (1977, p. 1) state that “[i]nformed consumers are protected consumers – more than that, they are liberated consumers.” They go on to recommend the creation of government sponsored *consumer information* (CI) programmes, including *comparative testing* carried out by e.g. the Consumer Union’s *Consumer Reports (Online)* in the U.S. and the creation of integrated *informative labelling* (IL) and *quality certification* (QC) programmes giving the consumer point-of-purchase information allowing him to compare the qualities of the products at hand.

Consumer Reports is a representative example of CI programmes for numerous goods. Recent innovations include an interactive Auto Insurance Price Service that lets the consumer compare up to 190 policies based on information provided by the consumer. The consumer will then get a personal report that lists as many

¹³Information-based remedies play an important role in contract law. In Germany, recent case law indicates that the Federal Court has written a transparency obligation into the fairness test according to which terms of contract are evaluated (see Reich (1991)). Examples include manufacturers’ warranties and bank charges. Lacking direct regulation of contract terms, case law shows that the terms must be spelled out in such a way that “the average consumer not having specific legal knowledge” will understand exactly what will be her rights or obligations according to the contracts. On this Reich (1991, p. 271) remarks that “... [t]ransparency serves a double objective: to improve the position of the individual consumer vis-à-vis the supplier, and to increase competition in a more transparent market.” Further, he claims (p. 267) that “[i]nformation-type regulations have proved to be very robust against any type of criticism.”

as 25 of the lowest priced policies allowing her to compare and choose the best deal.

The UK Director General of the Office of Fair Trading has surveyed private health insurance schemes, concluding that insurance policies are complex and that coverage varies “... making it difficult – if not impossible – for those outside the industry to compare policies in terms of value for money.” The Director General recommends that “... insurers could and should do more to facilitate easier comparison between policies in a given market, by drawing up ‘benchmark’ products based on a common set of terms and conditions” (OFT (1996)).

4.2. Collusion with Nash triggers

Given the reinterpretation of the basic model of Section 2, we can briefly restate the results in terms of our measure of transparency, θ .

4.2.1. Perfect collusion

By substituting θ for φ , the critical discount factor required to sustain perfect collusion is

$$\delta(\theta) \equiv \frac{T(\theta)}{T(\theta) + D(\theta)}$$

and we can state the following result on the relationship between the required discount factor and the measure of transparency.

Proposition 2. *$\delta(\theta)$ is strictly increasing in θ on $[0, \theta^{**})$, attains a maximum at $\theta = \theta^{**}$, and is strictly decreasing in θ on $(\theta^{**}, 1)$.*

Recall from Section 2 that $\theta^{**} \simeq 0.77$. Thus, if the aim of policy is to make perfect collusion sustained by Nash trigger-strategies as difficult as possible, then the optimal degree of market transparency is $\theta^{**} \simeq 0.77$. One may obviously doubt whether regulators have the information and instruments required to fix transparency at the optimal level, but this is beyond the scope of the present study. More importantly, we note that the optimal degree of transparency is *interior*. Furthermore, this particular model example suggests that perfect transparency is actually quite bad, since this is where the required discount factor to sustain full collusion is lowest!

4.2.2. Partial collusion

It follows directly from section 2.3.4, that if the discount rate $\delta \in (\frac{1}{2}, \delta(\theta))$, so that perfect collusion cannot be sustained by Nash triggers, the maximal, symmetric,

sustainable price, $p^{PC}(\delta, \theta)$, is increasing in θ from a certain level of transparency (that depends on the discount rate). This means that Fig. 1 applies with the substitution of θ for φ . The reason for this result is essentially that the Bertrand-Nash price p^N used for the potential punishment is falling at an increasing rate in θ (or φ).

In sum: Improved product comparability will decrease the partially collusive price $p^{PC}(\delta, \theta)$ for low values of δ and θ , but will increase p^{PC} when the discount rate is intermediate in size (between 0.5 and $\delta(\theta)$) and θ is sufficiently high. Thus, improved characteristics transparency *may* result in higher prices if the circumstances are right.

4.3. Harsher punishments

Let us briefly consider optimal symmetric penal codes in the sense of Abreu (1986, 1988). We study whether the perfectly collusive price p^C is sustainable by the following type of penal code. If a deviation is detected in any period, then firms switch to some punishment price p^P in the next period. Then, if both play p^P , the firms immediately switch back to collusive play p^C . Otherwise, firms continue to set p^P until both abide simultaneously, after which they switch back to p^C .

To make sense of this, we need some further notation.¹⁴ First, we generally define best deviation payoffs. Suppose firm 1 expects the rival to play some price $p_2 = p$. Then, if firm 1 plays a static best response, it attains payoffs $\pi^D(p, \theta)$. Adapting our previous notation, this implies $\pi^D(p^C, \theta) = \pi^D(\theta)$. Similarly, let $\pi^D(p^P, \theta)$ be the payoff to a firm that plays a best response to p^P in a punishment period. Finally denote by $\pi(p^P, \theta)$ the payoffs in a punishment period where both abide. Then, for the penal code above to support perfect collusion, the following must hold

$$\pi^D(p^C, \theta) + \delta\pi(p^P, \theta) \leq (1 + \delta)\pi^C \quad (4.1)$$

and

$$\pi^D(p^P, \theta) + \delta\pi(p^P, \theta) \leq \pi(p^P, \theta) + \delta\pi^C \quad (4.2)$$

(4.1) states that a defection from *collusion* followed by one round of abiding by the punishment is weakly dominated by collusion for two rounds. Similarly, (4.2) states that a defection from the *punishment* followed by one round of abiding by the punishment is dominated by one round of abiding by the punishment followed by one round of collusive play. We rewrite the requirements as

$$\pi^D(p^C, \theta) - \pi^C \leq \delta(\pi^C - \pi(p^P, \theta)) \quad (4.3)$$

¹⁴We follow Lambertini and Sasaki (1999), who have studied optimal, symmetric penal codes in a similar setting. See also Møllgaard and Overgaard (2001).

and

$$\pi^D(p^P, \theta) - \pi(p^P, \theta) \leq \delta(\pi^C - \pi(p^P, \theta)) \quad (4.4)$$

noting that the right-hand-sides coincide. If we can find a price $p^P(\theta)$ and a discount factor $\delta^P(\theta)$ which solve

$$\pi^D(p^C, \theta) - \pi^C = \delta^P(\theta)(\pi^C - \pi(p^P(\theta), \theta)) \quad (4.5)$$

$$\pi^D(p^P(\theta), \theta) - \pi(p^P(\theta), \theta) = \delta^P(\theta)(\pi^C - \pi(p^P(\theta), \theta)) \quad (4.6)$$

then collusion at p^C cannot be supported for $\delta < \delta^P(\theta)$, while the simple penal code above supports collusion at p^C when $\delta \geq \delta^P(\theta)$.¹⁵

If a solution exists, we can derive the lower bound, $\delta^P(\theta)$, on the discount factor required to sustain perfect collusion by Abreu-style penal codes and compare it with the critical discount factor found when firms are restricted to Nash trigger strategies, $\delta(\theta)$. Referring to Møllgaard and Overgaard (2001) for the formal details, we can state the following result.

Proposition 3. $\delta^P(\theta)$ is continuous and monotonically increasing in θ .

It turns out that $\delta^P(\theta) \rightarrow \frac{1}{4}$ for $\theta \rightarrow 0$, and $\delta^P(\theta) \rightarrow \frac{1}{2}$ as $\theta \rightarrow 1$. Hence, if we entertain the assumption that firms employ symmetric Abreu-style penal codes and if the aim of policy is to make perfect collusion as difficult as possible, then the optimal degree of transparency is $\theta = 1$. In this case we thus conclude that the fundamental trade-off is resolved in favour of perfect transparency. That is, in the comparison between the increased short-term incentive to defect and the increased severity of the potential punishment as transparency increases, the former dominates. This result is a close cousin to the one found by Schultz (2001) in his study of *price* transparency based on a repeated version of the Hotelling game.

4.4. More firms

Following Spence (1976a), we capture the case with n firms by generalizing the inverse demands of Section 2 as follows

$$p_i = \alpha - \beta q_i - \gamma \sum_{\forall j \neq i} q_j \quad (4.7)$$

This gives rise to direct demands of the form

$$q_i = \frac{1}{\beta + (n-1)\gamma} \left(\alpha - \frac{\beta + (n-2)\gamma}{\beta - \gamma} p_i + \frac{\gamma}{\beta - \gamma} \sum_{\forall j \neq i} p_j \right) \quad (4.8)$$

¹⁵See Abreu (1986).

For consistency with the duopoly case studied so far, we specialize demand somewhat. We retain the normalization $\alpha = 1$, and to suppress any preference or dis-preference for (perceived) variety, we assume $\frac{n}{\beta+(n-1)\gamma} = 2$, that is, $\gamma = \frac{1}{n-1}(\frac{n}{2} - \beta)$. Finally, we continue to write $\gamma = \theta\beta$, where $\theta \in [0, 1)$ is the measure of transparency. Solving for β and γ as functions of θ and n and substituting into the demand function, we obtain

$$q_i = \frac{2}{n} \left(1 - \frac{1 + (n-2)\theta}{1-\theta} p_i + \frac{\theta}{1-\theta} \sum_{\forall j \neq i} p_j \right) \quad (4.9)$$

Having thus changed the set-up to account for the general oligopoly case, the study of the relationship between the number of firms, the measure of transparency and the scope for tacit collusion in the dynamic game is largely a matter of replicating and suitably extending the arguments for the duopoly case. To save on space and spare the reader, we refer to Møllgaard and Overgaard (2001) for the relevant details. Here we just present a few elements of the analysis and the main conclusions.

Static Nash

Firm i chooses p_i to maximize

$$\pi_i(p_i; p_{-i}, \theta) = \frac{2}{n} p_i \left(1 - \frac{1 + (n-2)\theta}{1-\theta} p_i + \frac{\theta}{1-\theta} \sum_{\forall j \neq i} p_j \right) \quad (4.10)$$

where $p_{-i} = (p_1, \dots, p_{i-1}, p_{i+1}, \dots, p_n)$. The best response of firm i to p_{-i} is¹⁶

$$BR_i(p_{-i}) = \frac{(1-\theta) + \theta \sum_{\forall j \neq i} p_j}{2(1 + (n-2)\theta)} \quad (4.11)$$

The static Bertrand-Nash equilibrium prices, $(p_1^N, p_2^N, \dots, p_n^N)$, are

$$p_1^N = p_2^N = \dots = p_n^N = p^N(\theta, n) = \frac{1-\theta}{2-\theta + (n-2)\theta} \quad (4.12)$$

$p^N(\theta, n)$ is decreasing in n and $p^N(\theta, n) \rightarrow 0$ as $n \rightarrow \infty$. Further, for every n , $p^N(\theta, n) \rightarrow \frac{1}{2}$ for $\theta \rightarrow 0$ and $p^N(\theta, n) \rightarrow 0$ for $\theta \rightarrow 1$. Hence, the (static) equilibrium price converges to the competitive limit as either the number of firms increases without bound or the market becomes perfectly transparent. Profits

¹⁶As in the duopoly case this ignores the non-negativity constraints on individual quantities. This is dealt with in Møllgaard and Overgaard (2001).

are $\pi^N(\theta, n) = \frac{2}{n} \cdot \frac{(1-\theta)(1+(n-2)\theta)}{(2-\theta+(n-2)\theta)^2}$, which is strictly decreasing in the measure of transparency.

Collusion

Colluding firms set prices, $(p_1^C, p_2^C, \dots, p_n^C)$, to solve

$$\max_{p_1, p_2, \dots, p_n} \left\{ \sum_{i=1}^n \pi_i(p_i; p_{-i}, \theta) \right\}$$

and we obtain

$$p_1^C = p_2^C = \dots = p_n^C = p^C = \frac{1}{2}$$

which is independent of n and θ as “required”. The individual collusive profits, $\pi^C(n) = \frac{1}{2n}$, are independent of θ and decreasing in n , while the total collusive profits, $n\pi^C(n) = \frac{1}{2}$, are independent of both θ and n .

Best deviation

To derive the best deviation from collusive play, we suppose firm 1 anticipates all the other firms to set the perfectly collusive price p^C . Let $p^D(\theta, n)$ denote the best response to p^C given the measure of transparency and the number of firms and define $\theta^*(n) \equiv \frac{n-3+(n^2-1)^{\frac{1}{2}}}{3n-5}$, $n \in \mathbb{N} \setminus \{1\}$. Then tedious algebra reveals that the best response is

$$p^D(\theta, n) = \begin{cases} \frac{1}{2} - \frac{\theta(n-1)}{4(1+(n-2)\theta)} & \text{if } \theta \leq \theta^*(n) \\ \frac{1}{2} - \frac{1-\theta}{2\theta} & \text{if } \theta \geq \theta^*(n) \end{cases}$$

which generalizes (2.15). $\theta^*(n)$ is strictly decreasing in n , while $\theta^*(n) \rightarrow \frac{2}{3}$ for $n \rightarrow \infty$ and $\theta^*(2) = (3)^{\frac{1}{2}} - 1$. Hence, $\theta^*(n) \in (\frac{2}{3}, (3)^{\frac{1}{2}} - 1]$, $\forall n$. Note also that $p^D(\theta, n)$ is continuous in θ , $p^D(\theta, n) \rightarrow \frac{1}{2}$ for $\theta \rightarrow 0$, $p^D(\theta, n) \rightarrow \frac{1}{2}$ for $\theta \rightarrow 1$, and $p^D(\theta, n) < \frac{1}{2}$ for all $\theta \in (0, 1)$. Hence, as in the duopoly case, the best deviation is non-monotonic in transparency. Finally, with n firms, the static best response by firm 1 to collusive play renders all the rivals inactive if the market is sufficiently transparent, $\theta \geq \theta^*(n)$, while the rivals remain active if $\theta < \theta^*(n)$.

To complete, we note that the deviation payoffs are

$$\pi^D(\theta, n) = \begin{cases} \frac{(2-\theta+(n-2)\theta)^2}{8n(1-\theta)(1+(n-2)\theta)} & \text{if } \theta \leq \theta^*(n) \\ \frac{(1+(n-1)\theta)(2\theta-1)}{2n\theta^2} & \text{if } \theta \geq \theta^*(n) \end{cases} \quad (4.13)$$

where $\pi^D(\theta, n) \rightarrow \frac{1}{2}$ for $\theta \rightarrow 1$ and $\pi^D(\theta, n) \rightarrow \frac{1}{2n}$ for $\theta \rightarrow 0$. Furthermore, $\pi^D(\theta, n)$ is continuous in θ , and $\frac{\partial \pi^D(\theta, n)}{\partial \theta} > 0$, $\forall \theta \neq \theta^*(n)$. It follows that $\pi^D(\theta, n)$,

hence, the temptation to cheat, is monotonically increasing in the measure of transparency.

The repeated game and Nash threats

Let $D(\theta, n) \equiv \pi^C(n) - \pi^N(\theta, n)$ and $T(\theta, n) \equiv \pi^D(\theta, n) - \pi^C(n)$. When firms are restricted to Nash trigger-strategies, full collusion is sustainable if and only if the common discount factor satisfies

$$\delta \geq \delta(\theta, n) = \frac{T(\theta, n)}{T(\theta, n) + D(\theta, n)} \quad (4.14)$$

This critical discount factor, $\delta(\theta, n)$, is continuous in θ and differentiable everywhere except at $\theta = \theta^*(n)$. As a final piece of notation, let $\phi(\theta, n) \equiv (n^2 - 14n + 21)\theta^2 + 8(n - 3)\theta + 8$ and let $\theta^{**}(n) \equiv \max\{\theta \mid \phi(\theta, n) = 0\}$ whenever a solution to $\phi(\theta, n) = 0$ exists. Then, whenever $\theta^{**}(n)$ is in the unit interval, the required discount factor is maximized at $\theta = \theta^{**}(n)$, that is, the optimal degree of transparency is interior. Whenever $\theta^{**}(n) > 1$, the required discount factor is increasing in the measure of transparency on the admissible range, and in this case the optimal degree of transparency is full transparency.

>From the definition of $\theta^{**}(n)$, it is immediate that $\theta^{**}(n) < 1$ for $n = 2, 3, 4$, and $\theta^{**}(5) = 1$. Hence, the optimal degree of transparency falls short of perfect transparency, if the number of firms is less than five. We can summarize as follows:

<i>Number of firms</i>	2	3	4	5	6	...
<i>Optimal degree of transparency</i>	0.77	0.82	0.89	1	1	...

Alternatively, we could paraphrase Selten (1973) as follows: From the point of view of optimal characteristics transparency, four firms are few while six are many!

To the extent that the latter type of result is reasonably robust, it is of immediate relevance for policy discussions. Suppose, hypothetically, that the relevant antitrust authority has the requisite information on the underlying consumer demand, the nature of the consumer uncertainty as to the substitutability of the available goods (viz. insurance policies) and the necessary instruments to tune markets transparency to the desired level. Then the optimal policy depends delicately on the fine details of consumer preferences and the number of firms in an industry. Among other things, the agency might have to adjust the instrument following entry into or exit from an industry.

On the more reasonable assumption that the authority is only able to change the degree of market transparency in a rather crude and imprecise way, then the policy advice becomes rather more ambiguous. When the number of firms in an industry is large, increases in transparency are likely to make tacit collusion

harder to sustain for the firms. When the number of firms is small, the effects of increases in transparency on the scope for tacit collusion are unclear. If market transparency is initially very poor, then increases are likely to limit the scope for oligopolistic coordination, but if transparency is already high, then further increases might actually serve to facilitate collusion. If changes in transparency also affect the information of firms directly as considered in Section 3, then the ambiguity looks even less favourable.

5. Policy Towards Online and Off-line Transparency

As suggested by the formal results surveyed above, the effects of increased market transparency on competition and market efficiency are somewhat ambiguous and depend on the specifics of a given case. To summarize very roughly, we conclude that improved information flows between firms have a clear potential to facilitate collusion and dampen price competition in a dynamic setting. Improved information flowing to consumers seems to have rather ambiguous effects: If market behavior is largely myopic, then increased transparency is likely to intensify price competition. However if firms, in particular, are forward-looking, then increased consumer sensitivity to prices may or may not facilitate collusion.

In passing, we should note that our model allows for analyses of transparency “packages”: If an enforcement agency or an online exchange allows for better comparison of products as well as more precise and timely price information, this may be analysed as a simultaneous change of θ , δ , and ω . If δ is low, so that full collusion cannot be sustained, the maximal sustainable price $p^{PC}(\delta, \theta, \omega)$ is likely to increase because of the improved price transparency (the direct effect) but to fall because of improved comparability of products (the indirect effect).¹⁷ However, if characteristics transparency is already good (θ is large), then all three variables will contribute to a higher p^{PC} . Thus, in oligopolistic markets that are already fairly transparent, the authority should be particularly wary of further improvements of transparency – be they based on online or off-line technology.

In actual cases, we will typically have to add to the effects studied above that improved transparency from the perspective of consumers economizes on search costs (it brings down the effective price faced by potential customers at different outlets), which in itself will contribute positively to market efficiency. This effect is often hailed as *the* main benefit of the Internet (viz. comparison shopping and online auctions/exchanges). Below we will try to briefly discuss some practical cases and issues that confront public agencies in relation to market transparency and information dissemination. While we start out with an example from the

¹⁷See section 3.3.

bricks-and-mortar economy, we shall mainly relate the discussion to “new” issues raised by the growth of *online* markets and exchanges.

To motivate the policy discussion, we shall comment on a very *concrete* case which we have presented more fully elsewhere (see Albæk, Møllgaard and Overgaard (1997)). A few years ago, the antitrust authority in Denmark concluded that the markets for *ready-mixed concrete* showed signs of weak competition. Due to significant transportation costs, markets for ready-mixed concrete tend to be fairly local in nature. Also, each region is typically served by less than a handful of firms, and pricing is replete with examples of significant, secret rebates (mainly for large orders). To the extent that actual prices for specific deliveries were truly secret between the buyer and the supplier, these markets might be said to be *non-transparent*. Based on this, the authority argued that it was difficult for buyers (building contractors) to shop around for bargain prices, and if the pricing in the industry could be made more transparent,¹⁸ then firms would be forced to compete more vigourously for customers.

Given the theoretical modelling above, the arguments of the antitrust authority could be motivated in one of two ways. First, if market participants are assumed to be fairly myopic, then increased *price* transparency from the point of consumers should intensify price competition as in the static Bertrand-style models considered above. Second, the authority might be slightly more sophisticated and realize that improved price transparency from the point of view of potential customers involves a trade-off when firms are forward looking, but that from the perspective of dynamic price competition this trade-off is resolved in favour of transparency.¹⁹ On either of these arguments, improved price transparency might reasonably be expected to intensify dynamic price competition in the markets for ready-mixed concrete.

At any rate, the authority decided to sample and regularly publish *firm-specific* average prices and largest discounts in three regions. In one region, the prices of all firms were sampled. Following the publication of these data, average prices in this region increased by about 20 percent within six months. This was in a situation where the prices of raw materials (notably cement, energy and labour) remained constant and there was excess capacity in the sector. Thus, it is difficult to see why prices should go up in this region alone – if not for reasons

¹⁸In this industry goods are completely standardized, in the sense that the buyer demands a particular grade of concrete. Thus, in this case there does *not* seem to be any meaningful scope for buyer confusion as to the *characteristics* of products from different suppliers.

¹⁹The authority could have reasoned along the lines of the modelling in Schultz (2001). Schultz’s modelling is based on an underlying Hotelling-framework that might capture central elements of regional markets for ready-mixed concrete. For a description of the markets, see Albæk, Møllgaard and Overgaard (1997).

of improved price transparency: We argue that in this industry, characterised by lumpy orders, the effect of the publication of firm-specific price data was to decrease the detection lag and/or increase the probability of detection. It is then consistent with our discussion of partial collusion that when the discount factor is such that full collusion cannot be sustained, the maximal sustainable price will increase, if the probability of detection goes up and/or the detection lag is shortened. By ignoring the direct effect of price transparency, the authority may thus have facilitated collusion!

Transparency Online

That improved market transparency in the online economy involves a fundamental trade-off is increasingly being realized by (at least some) antitrust enforcement agencies. In relation to *online B2B exchanges*, FTC Commissioner Orson Swindle has recently remarked that "... it is clear that while a B2B exchange can be very procompetitive, such an arrangement can also give rise to anticompetitive information-sharing among actual or potential competitors. This can increase the likelihood of collusion on price, output, or other competitive variables, to the detriment of competition and consumers. Ease of access to common cost or pricing information via websites could increase sellers' incentives and ability to collude" (<http://www.ftc.gov/speeches/swindle/princetonclub2k.htm>).²⁰

On a related note, the EU Commission has recently expressed some doubts as to the blessings of market transparency. In a public remark on emerging *Internet exchanges*, the Commissioner for Competition, Mario Monti, noted that "...[w]hen examining the anatomy of cartels, we must...take into account the impact of ...new technologies. ...[I]n some cases collusion is facilitated by new technologies that allow for rapid dissemination of information and create more transparency in the market" (see Monti (2001, p. 16)).

The Danish Competition Authority (DCA) has followed suit in a recent public statement (see DCA (2001)). In that statement, it is realized that in relation to *B2B exchanges* there are several issues of potential concern to the agency. These include who organizes the exchange, which pieces of information are made available, and who has access to enter and extract information from a given site. It is specifically noted that the increased transparency (on prices and characteristics) associated with an online exchange may not be *intended* to stifle competition. On the contrary, it may be intended to facilitate comparison shopping. But, in actual cases the ultimate *effect* may be to facilitate tacit collusion.²¹

²⁰A more general statement of potential American antitrust concerns in relation to information-sharing and improved transparency through B2B exchanges can be found in FTC (2000).

²¹Note, though, that the official Danish attitude towards markets transparency remains some-

These comments are too abstract and general to provide any guideline for actual antitrust practice *vis a vis* online institutions. This may, of course, reflect our limited understanding at the current stage of the working of e-commerce and online trading. However, concerns like those raised above have generated a renewed interest among academics and antitrust practitioners in information sharing and market transparency. The US Federal Trade Commission has issued a report on electronic B2B market places (see FTC (2000)) and the UK Office of Fair Trading has issued a report on e-commerce (see Frontier Economics (2000)). Similarly, in the academic literature, several papers have recently dealt with information dissemination and market transparency in relation to online trading and information exchanges and with the challenges they raise for antitrust enforcement (see e.g. Kühn (2001) and Halliday and Seabright (2001)). These contributions largely seem to agree that the challenges raised are not conceptually new, but that antitrust has to keep a particularly keen eye on certain online activities.

Kühn (2001) which builds extensively on Kühn and Vives (1995) is not exclusively, or even mainly, concerned with e-commerce and online exchange. Instead, the focus is on establishing some general guidelines for fighting collusion that relies heavily on the regulation of the exchange of information between firms.²² As such it is of general relevance for the discussion in this paper. More specifically, it is of interest here since Halliday and Seabright (2001), who are mainly concerned with antitrust and regulation in the online economy, take issue with some of the general principles expounded by Kühn. Roughly, Kühn suggests that collusion should be fought by regulating the information firms are allowed to exchange, and on identifying certain kinds of information exchange as signs or evidence of collusion. The focus of Kühn as well as Kühn and Vives (1995) is on the *content* of the information exchanged. From the content of the information exchanged or publicized, the antitrust enforcement agency should assess whether this information could possibly (or predominantly) serve a socially beneficial end (such

what unclear. Following a long tradition of considering transparency as a main instrument of antitrust (see Albæk, Møllgaard and Overgaard (1996, 1998)) the Danish Ministry of Trade and Industry (1999, p. 9) boldly asserts that "... the most effective means of generating intensive competition is ... often not the concrete measures of the competition authorities, but to give consumers information, so that they may choose the best and cheapest products" (our translation). To this end, it has proposed more price surveys *and* the establishment of a *web-based* consumer data bank in which *firms* (and others) may enter reliable and certifiable information on prices and product characteristics. This, of course, might constitute a government-sponsored and, thus perhaps, credible information exchange between competing firms!

²²This should be contrasted with a more traditional approach that relies on inferring collusion from observed pricing behaviour. A main problem in that approach is one of identification, in the sense that prices that might in one interpretation be taken as an indication of collusion, might under an alternative (and equally well-founded) interpretation be considered highly competitive.

as allowing potential customers to plan and eliminate risk) or whether it largely serves to enable coordinated price-adjustments (non-binding announcements of future prices)²³ or policing of a tacitly collusive agreement (rapid dissemination of firm-specific invoice prices and outputs).

While presumably agreeing at a general level with the focus on information exchange in fighting collusion, Halliday and Seabright (2001) express some skepticism towards the content-based approach of Kühn and Vives. In the abstract, they make the point that whatever the content of an information exchange, it cannot be intrinsically bad. What matters is the use made of the information exchanged. This is largely in line with our theoretical modelling: The rapid dissemination of price information might be exploited mainly by consumers to shop around and thereby put pressure on firms to lower prices. On the other hand, the same kind of information might be exploited mainly by firms to tidy up a collusive oligopoly act.

More specifically, Halliday and Seabright argue that any attempt by an enforcement agency to regulate the precise content of a *digital* information exchange is a non-starter. Any information can be encoded easily and at low cost. Similarly, policing conversations in a password-protected *chat room* sponsored by firms may prove difficult. This perspective is mirrored by the OFT report (Frontier Economics, p. 53) which remarks that "...chat rooms would be very hard to monitor, and the information would be easy to delete entirely from the chat room server (if saved in the first place)."²⁴ A related point is that banning the information exchange between firms is of little avail, if information brokers quickly perform the same task. What authorities should do instead, is to make sure that all market participants have access to the information. Industry-sponsored exchanges may tend to deny access to customers, while independent exchanges might not. The upshot of this is that regulators should care more about *access* to and *ownership*

²³At this point retail gasoline prices spring to mind. Following exogenous (?) changes in wholesale prices (from variations in exchange rates or crude oil prices), it is a widespread practice for one firm to pre-announce a price change, and for the rest of the industry to quickly follow suit. On the face of it, this seems to be a classic example of an exchange of information on future intentions, which could serve a coordinating role in a dynamic oligopoly marred by strategic uncertainty (viz. the Folk Theorem). Whether such a "system" of price adjustment has any redeeming features, then depends on whether there is any commitment *vis a vis* customers in the initial announcement, or whether it can be recalled more or less costlessly, if the rest of the industry does not follow. We leave to the reader to make up his own mind on this.

²⁴Kühn (2001, p. 20) take issue with this pessimism towards the policing of communication on the Internet. He argues that while acquiring and disseminating information has become cheap, so has the original "creation" of information. He argues that even a careful cartel conspirator may fail to eliminate all incriminating information - it is simply too costly to completely destroy information.

of an information exchange than about the exact content of the information being exchanged. Access and ownership, of course, partially reveal whose interests were mainly being served when the exchange was set up.

>From the perspective of our theoretical modelling, an information exchange owned and operated by firms which denies access to customers suggests that firms have reasoned that the information exchanged in private facilitates price coordination, while exchanging the information in public would have been detrimental to long-term profits. On the other hand, an information exchange which allows free access to customers might actually suggest that these firms believe that improved transparency on the consumer side might improve the scope for tacit collusion. So, from a theoretical perspective it is not necessarily true that universal access is beneficial from the perspective of dynamic competition.²⁵ In the latter case, the enforcement agencies will have to determine whether closing the exchange to customers or closing it altogether is possible and socially optimal.

To end this section, let us briefly mention a couple of issues that should be of particular interest to antitrust enforcers (we refer the reader to FTC (2000) and Frontier Economics (2000) for more details and examples).

A remark on chat rooms. We should note that the industry-sponsored chat rooms referred to above do not have to bear any relationship to an *electronic market exchange* (B2B or B2C). This might as well be established by the trade association of a very traditional *bricks-and-mortar* industry. It could be a perfectly legitimate venue for industry discussions of product standards, etc. Such a venue, suitably password-protected, might be a very safe alternative to meetings in a trade-convention hotel room to coordinate price setting. We imagine that some of the (in)famous cartels of the last century might have been able to put such a chat room to “good use”.

The integration of online marketplaces and internal IT systems. From stock and commodity exchanges we are used to the notion of automated trading, where a computer programme executes the strategy of a market participant. In an oligopolistic industry competing in an electronic online marketplace with complete (real time) price transparency, there is a clear scope for players to pre-programme and execute highly collusive and sophisticated contingent strategies that might look much like the ideal taken from an advanced game theory text book. This presents an important regulatory challenge.

Low adjustment costs and quick responses. As suggested by the discussion

²⁵Halliday and Seabright (2001, p. 85) comes close to arguing that an information exchange which is accessible to customers is necessarily benign (since it allows comparison shopping), while an exchange which is opaque to buyers will be designed only to identify defections from collusive agreements.

of detection lags, tacit collusion is facilitated by quick responses to unilateral defections. A quick response is obviously facilitated by low costs of making price changes (sometimes referred to as menu costs, see e.g. Frontier Economics (2000, p. 55)). Such low costs of making a price change seems to be a distinguishing feature of many electronic marketplaces, where changing a price is just a matter of typing a few numbers on a keyboard and pressing Enter.

From dealer sales to online auctions. Klemperer (2000) has commented on the sale of *new* cars in the UK. Included in this is a pertinent discussion of *price transparency* in the context of auction theory applied to Internet-sales by auction versus traditional dealer-sales.²⁶ He argues that Internet-sales are like collusion-prone *second-price* auctions, while dealer-sales are more like non-transparent *first-price* auctions not allowing dealers to infer rivals' secret price cuts. The flip-side is, of course, that Internet-sales may eliminate significant search costs for the consumers. It will be interesting to follow how these, possibly opposing, effects play out in practice, but from a purely theoretical perspective it is less than entirely clear that these Internet cars sales will ultimately benefit consumers compared to the traditional trading institution.²⁷

6. Concluding Remarks

In this paper, we have studied the interplay between various forms of market transparency and dynamic price competition in oligopoly. Improved transparency from the perspective of firms may under reasonable assumptions increase the scope for collusion, while improved transparency from the perspective of consumers may well intensify price competition. The latter, however, is subject to some caveats. On top of this, improved transparency may eliminate search costs, primarily on the part of consumers. So, based purely on theory, it remains somewhat ambiguous whether improved market transparency is predominantly in the public interest. Improved market transparency may be good or bad; it all depends on the details of the specific case under scrutiny.

Therefore, we have also tried to relate the theoretical considerations to a range of practical problems that confront regulators and antitrust enforcement agencies. In this we have mainly focused on issues that seem to be of particular relevance in the modern electronic marketplace. To the extent that the most distinguishing

²⁶In the Internet auction the bidders are dealers competing to fill the orders made by customers.

²⁷According to the logic of Halliday and Seabright (2001), regulators should take a keen interest in who is organizing these exchanges and in who has access to the different pieces of information created by the auction design.

feature of the online economy is the rapid dissemination of information, then the message to government agencies is that they should allocate significant resources to develop a better understanding of the interaction between information and competition with a view to establishing a coherent set of policy guidelines.

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