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The Impact of Consumer Inertia**

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# Competition versus Collusion: The Impact of Consumer Inertia[*]

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### Abstract

We consider a model of dynamic price competition to analyze the impact of consumer inertia on the ability of firms to sustain high prices. Three main consequences are identified, all of which contrast with predictions of the standard model of collusion: ($i$) maintaining high prices does not require punishment strategies when firms are sufficiently myopic, ($ii$) if buyers are sufficiently inert, then high prices can be sustained for all discount factors, and ($iii$) the ability to maintain high prices may depend non-monotonically on the level of the discount factor when the industry exhibits network externalities and demand is sufficiently viscous. These results provide a number of interesting insights with regard to competitive and collusive pricing behavior. In particular, we illustrate how direct communication between firms may facilitate collusion.

*Keywords:* Collusion, Consumer Inertia, Dynamic Competition.

*JEL Codes:* C73; D43; L13; L41.

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# 1 Introduction

Standard theory of industrial collusion assumes that firms essentially face a prisoner's dilemma when attempting to fix prices above competitive levels. Slightly undercutting the collusive price presumably leads to an immediate and substantial increase in sales and thereby profits. Following modern economic theory, firms can sustain high prices by ensuring that cheating does not go unpunished. Firms will then have an incentive to abide by the collusive agreement when short-run gains of cheating fall short of future losses, which typically requires a credible punishment strategy as well as a sufficiently high discount factor.[1] The notion that colluding oligopolists are confronted with an intertemporal trade-off between short-term gains and future losses lies at the heart of most contributions to the theory of industrial collusion.

A critical assumption in these studies is that a seller can indeed increase its sales instantly and significantly by shaving its price below the agreed level. While clearly there are instances in which consumers respond quickly to price changes, it is often more realistic to assume that they will not switch suppliers instantaneously. For example, in many industries, customers exhibit brand loyalty, switching costs or a lack of information on the price and quality of competing products. Also, buyers may have established long-term contracts with their suppliers.[2] These types of consumer inertia directly affect the intertemporal trade-off that oligopolists face. Given that demand is viscous, undercutting the collusive price does not lead to a short-term gain but a loss. This holds because individual demand is not immediately affected by the change in price and existing customers spend less on the product or service. At the same time, however, cutting price might lead to additional future profits as buyers may switch over time to a lower priced firm.[3]

The notion that buyers may not respond instantly to a price cut generates a number of interesting questions. How does (the degree of) consumer inertia affect the ability of firms to sustain collusion? Under what industry conditions can we expect firms to set high prices? In this paper, we explore these and related issues. We consider a model of dynamic price competition in which two sellers interact for an infinite number of periods.[4] In any given period, customers are loyal to their seller independent of the price it charges.[5] Hence,

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[1]Friedman (1971) was among the first to show that collusion is sustainable in the context of an infinitely repeated game when firms are sufficiently patient.

[2]Klemperer (1995) provides many arguments for why buyers may not instantly respond to a price cut.

[3]Strategic pricing behavior in the presence of demand viscosity is also studied in Chen and Rosenthal (1996) and Radner (2003). However, these papers do not consider the impact of consumer inertia on (tacit) collusion.

[4]A similar setting is studied in Pot, Flesch, Peeters and Vermeulen (2009), which fully characterizes the set of stationary equilibria. However, this paper does not consider more sophisticated strategies and collusive behavior.

[5]An alternative interpretation is that consumers face substantial switching costs. See, for example, Farrell and Shapiro (1988) and Beggs and Klemperer (1992).

firms have some market power over their existing customers. However, buyers might switch suppliers in future periods if they observe a price difference. Consequently, in deciding whether or not to cut price, firms are given the following options. On the one hand, a seller may charge a high price and thereby exploit its current customer base ('harvesting incentive'). Yet, by doing so, it faces the risk of losing customers in the future when its rival chooses to price low. Alternatively, a seller may charge a low price, thereby foregoing short-run profits, but with some probability increase its market share in the future ('investment incentive').

In deciding whether or not to deviate from the collusive price, there are at least three factors that play an important role. First, this decision will be driven by the amount of additional sales that can potentially be obtained by cutting price. This depends on the relation between consumer tastes and preferences and product attributes. For instance, if products are significantly differentiated, then a price cut will only attract a limited number of additional buyers. Second, the decision depends on the likelihood that customers will indeed switch suppliers. This is a dynamic factor, which includes loyalty and informational effects. For example, a customer who purchased from a particular seller may, *ceteris paribus*, be more inclined to buy from this seller in the future. That is, consumers might not always opt for the cheapest product even when the products are functionally identical.[6] Third, sustainability of high prices depends on the value of expected additional sales. Indeed, like in the standard model of collusion, the rate that is used to discount future profits is an important determinant of strategic pricing behavior. These three factors are all taken into account in our analysis.

Summarizing our main results, sustainability of high prices does not require punishment strategies when firms are sufficiently myopic. This result holds for all customer preferences and any degree of consumer inertia. Moreover, high prices can be sustained for all discount factors when demand is sufficiently viscous.[7] Finally, we find that the ability to maintain high prices might depend non-monotonically on the level of the discount factor. That is, collusion may be sustainable for extreme values of the discount factor, but not when firms are moderately patient. For this to occur, it is required that the industry exhibits network externalities and that buyers are sufficiently inert.

All these results contrast with predictions of the standard model of collusion and therefore provide a number of interesting insights with regard to strategic pricing behavior. For example, our analysis sheds some light on when we may expect competition and collusion to lead to

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[6]One way to think about this is that there is an informational advantage about the quality of the product when used before. As a consequence, a customer has to put some (costly) effort in finding out whether he could better switch or not. Likewise, customers may be slow to become aware of the most attractive brand due to a lack of (or a lag in) relevant information.

[7]This contrasts with Padilla (1995) who finds that tacit collusion in markets with switching costs is more difficult to sustain than in markets without switching costs.

similar market outcomes.[8] This is valuable information in light of antitrust enforcement, particularly because economic methods of cartel detection typically aim to discriminate between competitive and collusive pricing behavior.[9] Moreover, for a particular degree of consumer inertia, a credible and severe punishment strategy might be insufficient to sustain high prices in some types of industries. In this case, firms may try to influence the level of inertia to create a situation in which high prices can be sustained. For instance, sellers may agree not to advertise in each others home markets. In this paper, we argue how such direct communication may help firms to facilitate collusion.

This paper proceeds as follows. In the next section, the model is introduced and described. Section 3 solves the model and provides a full characterization of high price equilibria. In Section 4, we discuss implications of our main findings. A formal illustration of how direct communication about prices may facilitate collusion is provided in Appendix A. All proofs are in Appendix B.

## 2 Model

Our prime purpose is to explore the qualitative impact of consumer inertia on the ability of firms to sustain high prices. To that end, we study an infinitely repeated price game between two sellers. Akin to a prisoner's dilemma, both can choose between two actions: a high (collusive) price $H$ and a low (competitive) price $L$. As demand is viscous, customers will not respond immediately to price changes. We take account of this by assuming that, in any given period, pricing decisions can only have an effect on future sales. Note that this implies that charging a high price is a dominant strategy in the one-shot version of this game. Moreover, consumers might only consider switching when they can obtain the product or service at a lower price. Consequently, cutting price leads to a decrease in immediate profits with certainty, but a potential increase in future profits.

Given a common discount factor $\delta \in [0, 1)$, both firms maximize the expected present value of their profit stream. Notice that the presence of demand viscosity gives firms temporary market power, which fundamentally alters the intertemporal trade-off that oligopolists face in traditional models of industrial collusion. In a repeated prisoner's dilemma, firms compare short-term gains with future losses when deciding whether or not to cut price. If buyers are inert, then undercutting the collusive price is beneficial only when expected future profits outweigh short-term losses. Hence, firms have to decide whether to exploit their current customer base by charging a high price or to increase or protect their market share by setting

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[8]This possibility is also suggested by Radner (2003).
[9]See Harrington (2008) for an overview and discussion of economic methods of cartel detection.

a low price. In principle, any future reward would be sufficient to capture this intertemporal trade-off.[10] Here, we model potential future gains by two absorbing monopolistic states. The structure of the game is depicted in Figure 1.
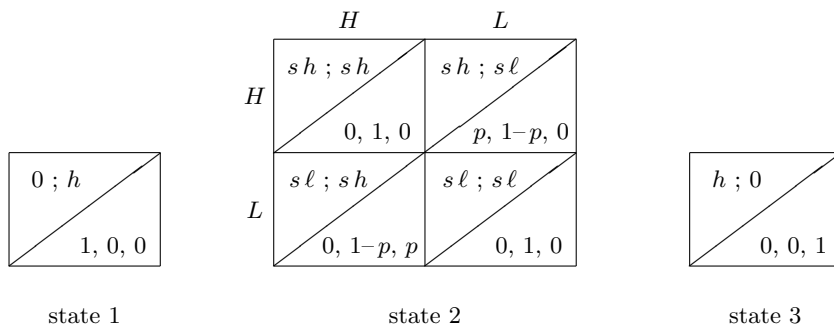


Figure 1: A duopolistic model of dynamic price competition with consumer inertia. In each cell, the north-west part shows respectively the profit of firm 1 (the row player) and firm 2 (the column player); the south-east part shows respectively the probability to transit to state 1, state 2 and state 3.

The price game contains three states; one competitive state (state 2) and two absorbing monopolistic states in which one of the firms has captured the entire market (state 1 and state 3). Starting in the competitive state, firms simultaneously and independently set a price. If both firms choose the same action, then play resumes with probability 1 in the competitive state. In this state, sales are assumed to equal $s \in (0, 1)$ for both firms. Costs of production are normalized to 0 and fixed costs are absent. As a result, depending on whether firms opted for $H$ or $L$, profits in the competitive state are respectively given by $sh$ or $s\ell$ (with $h > \ell > 0$). If firm $i$ chooses $L$ and its rival chooses $H$, then play resumes with probability $p \in (0, 1]$ in the absorbing state in which firm $i$ is a monopolist. With probability $1 - p$, play resumes in the competitive state. In the monopolistic state, the surviving firm earns a profit of $h$ every period.

In this setting, both parameters $p$ and $s$ have a broader interpretation. The parameter $p$ is the probability that a price cut is successful in attracting additional sales. It therefore captures the degree of consumer inertia. For example, higher values of $p$ correspond to lower switching costs, more price awareness or less brand loyalty. The parameter $s$ represents the sales of a firm in competition relative to the sales it makes as a monopolist. When $s \geq \frac{1}{2}$, total sales in the competitive state (weakly) exceed the amount a monopolist can sell. This is characteristic for markets with differentiated goods or when products are complements. Thus, a larger $s$ can be interpreted as a higher level of differentiation or complementarity. By contrast, when $s < \frac{1}{2}$, total sales are higher when the market is served by one firm. This

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[10]Pot *et al.* (2009) provides analysis and evidence.

is typically the case when both firms sell incompatible network goods. A smaller $s$ then corresponds to a higher level of consumptive externalities. The parameters $p$ and $s$ thus allow us to take account of various degrees of demand viscosity and different types of markets.

## 3 Results

The model we study is contained in the class of finite discounted stochastic games and we will use the conventional concepts and methods. In this model, the most general type of strategy a firm can formulate is a behavior strategy in which decisions are conditioned on state, time, full history of all visited states and all actions chosen. A pair of behavior strategies constitutes a Nash equilibrium if, given the initial state, neither of the firms can improve its (expected) profits by unilaterally adopting another behavior strategy. One particular type of behavior strategy that firms can employ is a stationary strategy, in which decisions are independent of time and history and therefore conditioned on states only. A pair of stationary strategies that constitutes a Nash equilibrium is called a stationary equilibrium. If there does not exist any combination of state, time and history that allows a firm to profitably defect, then the Nash equilibrium is called subgame perfect.

The next result shows that high prices can be supported as a stationary subgame perfect equilibrium if and only if the discount factor is sufficiently low.

**Proposition 1** (stationary behavior). *High prices are sustainable as a stationary subgame perfect equilibrium if and only if*

$$\delta \leq \delta_H \equiv \frac{s\,(h-\ell)}{s\,(h-\ell)+p\,(1-s)\,h}.$$

There exists no high price stationary subgame perfect equilibrium for high discount factors, because then the investment incentive dominates the harvesting incentive. Yet, high prices may still be sustainable as a subgame perfect equilibrium when firms adopt slightly more sophisticated strategies, *e.g.*, trigger strategies. A trigger strategy basically consists of three parts: (1) a specification of the collusive strategy, (2) a specification of a punishment strategy to be adopted in the event of deviation from the collusive strategy, and (3) a specification of a strategy to be adopted when punished by the rival.

Firms choose high prices in the collusive phase. In case of defection, the most effective punishment is to price low. Note that as the punishment strategy is stationary, the deviating firm has a stationary best response. However, whether the punished firm responds by charging a high or a low price depends on the level of the discount factor. The punished firm optimally sets a low price when $\delta \geq \delta_L \equiv \frac{h-\ell}{h-(1-p)\,\ell}$ and a high price when $\delta < \delta_L$. The reason for this is

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that, when the discount factor is below the threshold $\delta_L$, the immediate costs of fighting for survival exceed the future benefits of being in the competitive state.

In sum, the trigger strategy for both firms is given by

$$T = \begin{cases} H & \text{if } L \text{ has not been chosen in any of the previous periods (collusion)} \\ L & \text{if the rival was the first to choose } L \text{ (punishment)} \\ H & \text{if one was the first to choose } L \text{ and } \delta < \delta_L \text{ (reaction to punishment)} \\ L & \text{if one was the first to choose } L \text{ and } \delta \geq \delta_L \text{ (reaction to punishment).} \end{cases}$$

Notice that, when both firms adopt this trigger strategy, the way the punishment affects the deviating firm's future profits differs for the two different ranges of the discount factor. For discount factors below $\delta_L$ there are no consequences for the future per-period profits as long as the market is in the competitive state, but in every future period there is a positive probability to be driven out of the market. For discount factors above $\delta_L$ there is a relative loss in all future per-period profits, while none of the firms will ever obtain a monopoly position (like in the case without deviation).

Next, we analyze when the trigger strategy profile constitutes a subgame perfect equilibrium. For this to be the case, there are two requirements. First, the strategies employed in the punishment phase should constitute a (stationary) subgame perfect equilibrium. Second, deviation from the coordinated high price strategies should not be beneficial. The first requirement is guaranteed to be satisfied according to the following proposition.

**Proposition 2** (punishment). *Decisions in the punishment phase constitute a stationary subgame perfect equilibrium.*

The conditions under which the second requirement is met depend on the value of the discount factor $\delta$ relative to the threshold $\delta_L$, because this determines the strategy that will be adopted in the punishment phase.

**Proposition 3** (sustainability). *Let $\delta \geq \delta_L$. High prices are sustainable in subgame perfect equilibrium if and only if*

$$\delta \leq \delta_{LL} \equiv \frac{s(h-\ell)}{p(h-s\ell)}.$$

*Let $\delta_H < \delta < \delta_L$. High prices are sustainable in subgame perfect equilibrium if and only if*

$$\delta \notin (\delta_{LH}^-, \delta_{LH}^+),$$

*with*

$$\delta_{LH}^- \equiv \frac{2(1-p)s(h-\ell)+p(h-s\ell)-\sqrt{[2(1-p)s(h-\ell)+p(h-s\ell)]^2-4(1-p)s(h-\ell)[s(h-\ell)+ph]}}{2(1-p)[s(h-\ell)+ph]}$$

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*and*

$$\delta^+_{LH} \equiv \frac{2\,(1-p)\,s\,(h-\ell)+p\,(h-s\,\ell)+\sqrt{[2\,(1-p)\,s\,(h-\ell)+p\,(h-s\,\ell)]^2-4\,(1-p)\,s\,(h-\ell)\,[s\,(h-\ell)+p\,h]}}{2\,(1-p)\,[s\,(h-\ell)+p\,h]}.$$

The first part of Proposition 3 specifies the condition for which high prices are sustainable when in the punishment phase the punishing firm sets low prices and the deviating firm responds optimally by charging a low price. The condition states that high prices are sustainable as long as the discount factor does not exceed $\delta_{LL}$. Observe that the threshold $\delta_{LL}$ can give rise to two scenarios. If $\delta_{LL}$ is less than one, then high prices cannot be sustained for high discount factors (Scenario 2); otherwise high prices are sustainable for discount factors arbitrarily close to one (Scenario 1).

The second part of Proposition 3 specifies the condition for which high prices are sustainable when in the punishment phase the punishing firm sets low prices and the deviator responds optimally with a high price. The condition shows that, with the exception of an interval of intermediate values of the discount factor, high prices are sustainable in equilibrium. As before, two scenarios may arise, depending on whether the interval $(\delta^-_{LH}, \delta^+_{LH})$ has a nonempty intersection with the interval $(\delta_H, \delta_L)$ (Scenario b) or not (Scenario a).

Combining Propositions 1, 2 and 3, we summarize our findings in the following theorem.

**Theorem 4.** *The effect of the discount factor on the sustainability of high prices as a (stationary) subgame perfect equilibrium takes one of the four forms as depicted in Figure 2.*
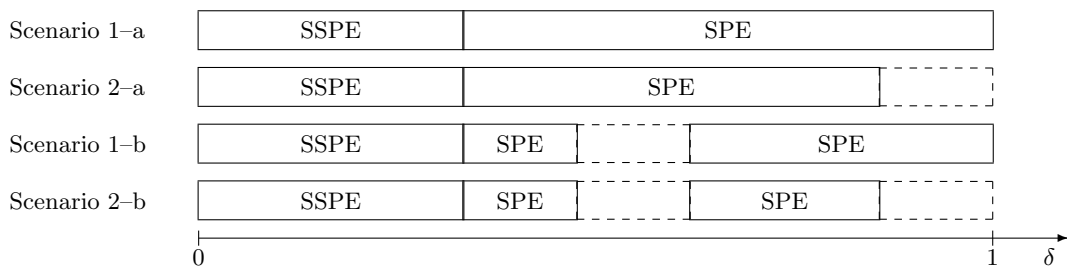


Figure 2: Sustainability of high prices by means of stationary strategies (SSPE) and trigger strategies (SPE) for different values of the discount factor. The values of the thresholds depend on the parameters $h$, $\ell$, $s$ and $p$ and are therefore not necessarily the same among the different scenarios.

Theorem 4 shows that the presence of consumer inertia results in three main differences compared to an infinitely repeated prisoner's dilemma game. First, while it is well-known that in standard models of collusion high prices can be sustained in a subgame perfect equilibrium when the discount factor is sufficiently high, we here find a reversed effect. In all four scenarios, high prices are an equilibrium outcome when the discount factor is sufficiently low.

The explanation for this is that firms are short-term focused when the discount factor is low. If buyers are inert, then firms can maximize their profits through exploiting their current customer base by setting a high price. Moreover, for very low discount factors, any changes in future market share are considered to be of little importance and setting a high price is a strictly dominant strategy.

**Remark.** If $\delta$ is sufficiently low, then the high price equilibrium is unique.

A second difference caused by consumer inertia is the possibility that high prices are sustainable as a subgame perfect equilibrium for every value of the discount factor (Scenario 1–a). As Theorem 4 shows, for high discount factors this requires the use of trigger strategies. If firms know that defecting will evoke a punishment phase in which low prices will be set in all future periods, then their only incentive to deviate is the possibility to obtain a monopoly position. However, if demand is viscous or when only a few extra consumers can be gained by cutting price, then this potential "reward" may be insufficient to justify the immediate profit decrease that results from choosing a low instead of a high price. If this is the case, then high prices can be sustained in equilibrium for all values of the discount factor.

A third difference with standard models of collusion is that there may be a non-monotonicity in the sustainability of high prices (Scenario 1–b and 2–b). This striking result can occur for intermediate values of the discount factor. In this range, deviating from the trigger strategy is followed by a punishment phase in which the deviator responds optimally to the low price of its rival by setting a high price. In this case, the deviating firm foregoes part of its immediate profit in exchange for a chance to be a monopolist from the next period onwards. In case monopoly is not attained, per-period profits of the deviator will be at collusive levels from the next period onwards, because choosing a high price is the optimal response to the punishment. Notice, however, that as the punishing firm sets a low price, the deviator faces the risk of losing its market share in every period. These rather subtle differences in the timing of different profit streams can give rise to the irregularity. Hypothetically, if we would let the discount factor increase from zero, we would find a threshold above which the expected profits of acquiring a monopoly position in period $t+1$ outweigh the immediate costs of cutting price in period $t$. At this point, high prices can no longer be supported as an equilibrium. Yet, if we would let the discount factor increase more, then the expected costs of losing market share from period $t+2$ onwards gains more weight. As a result, deviating becomes less attractive and high prices become sustainable again.

Which of the four scenarios applies depends on the value of the parameters $p$ and $s$, as the next result indicates.

**Theorem 5.** *The relation between the parameters $p$ and $s$ and the scenarios of Theorem 4 is as depicted in Figure 3.*
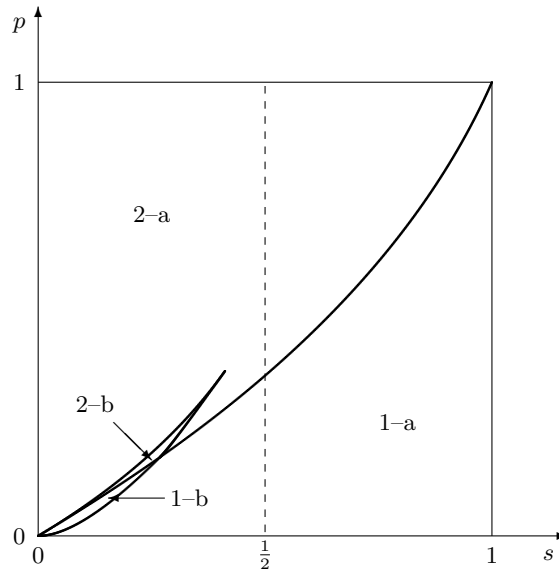


Figure 3: Relation between parameters and scenarios.

Scenarios 1–a and 1–b are characterized by high prices being sustainable for values of the discount factor arbitrarily close to one. Theorem 5 reveals that this situation arises for low values of $p$ and high values of $s$. In this case, chances of successful monopolization are low and the additional sales that can be obtained by cutting price are limited. As explained below Theorem 4, the reward of monopolization is not sufficient to justify the immediate profit decrease that results from choosing a low instead of a high price. This can be illustrated by looking at two extreme cases. If $p = 0$, it is impossible to acquire a monopoly position and the high price strategy is (weakly) dominant for all values of the discount factor. If $s = 1$, the collusive profits are equal to the monopoly profits. Consequently, firms have no incentive to strive for a monopoly position and setting a high price is a dominant strategy for any level of the discount factor.

In Scenario 2–a and Scenario 2–b, high prices are not sustainable for discount factors sufficiently close to one. Theorem 5 reveals that this situation may arise for high values of $p$ and low values of $s$. In this case, the probability on successful monopolization is significant and firms can potentially increase their sales substantially by cutting price. Looking at the extreme case where $p = 1$, undercutting the collusive price is guaranteed to be successful and firms that are sufficiently patient will surely aim to monopolize the market. In the other extreme case where $s = 0$, investment costs are zero and the punishment strategy will be

completely ineffective. Therefore, both firms would price aggressively to gain market share.

Finally, the banana-shaped area in Figure 3 reveals that the non-monotonicity in the sustainability of high prices (Scenario 1–b and 2–b) can only occur for low values of $s$ and $p$. In particular, such non-monotonicities will not be present for values of $s$ above $\frac{1}{2}$.

**Corollary 6** (traditional industries)**.** *Assume $s \geq \frac{1}{2}$. If high prices can be sustained at a given discount factor, then these can also be sustained at any lower discount factor.*

Hence, only when $s$ is sufficiently low (but certainly less than $\frac{1}{2}$), sustainability of high prices may depend non-monotonically on the level of the discount factor. Furthermore, it is required that $p$ is not too high, but not too low either.

**Corollary 7** (network industries)**.** *Assume $s < \frac{1}{2}$. It may occur that high prices cannot be sustained at a given discount factor, while these can be sustained for smaller and higher values of the discount factor.*

## 4  Discussion

A common assumption in the theory of industrial collusion is that undercutting the collusive price leads to an instant and substantial increase in sales and profits. In many industries, however, buyers are hesitant to switch suppliers in response to a price cut. This may for example be due to switching costs, contractual commitments and brand loyalty. In this paper, we have explored the impact of such consumer inertia on the ability of firms to sustain high prices. Contrary to predictions of the standard model of collusion, high prices are always sustainable when the value of expected future profits is sufficiently low. Moreover, there is a possibility that high prices can be maintained for all values of the discount factor. Finally, whether or not collusion is feasible may depend non-monotonically on the patience level of firms. If firms are only moderately patient, then high prices might not be sustainable when the industry exhibits network effects and demand is sufficiently viscous.

These results provide a number of interesting and important insights with regard to strategic firm behavior. First, our analysis reveals that high prices can be supported as a stationary subgame perfect equilibrium. Thus, setting high prices does not necessarily require an implicit or explicit coordination of actions. In particular, no triggers or threats are needed to reach the most profitable market outcome. High prices can therefore emerge naturally in competition and do not necessarily result from collusive practices. As such, this result is not new. For example, in markets with differentiated goods, firms typically have the power to raise prices without losing too many customers. Yet, a fundamental difference with our results is that the

stationary high price equilibrium can occur in all four scenarios and therefore does *not* rely on the degree of consumer inertia and differentiation (type of market). Consequently, high prices in competition may not be driven only by a demand-side characteristic (*e.g.*, consumer taste). In fact, we find that it is caused by a supply-side characteristic; the patience level of firms as reflected by the discount factor.

Moreover, when firms are sufficiently myopic, the stationary high price equilibrium is the unique equilibrium outcome. As the patience level of firms is typically unknown, this raises the question of how to distinguish between competitive and collusive pricing behavior. Arguably, low prices is the preferred market outcome from the perspective of consumers. Yet, in this situation, it seems difficult to effectively incentivize firms to no longer charge high prices. In particular, it is doubtful whether standard antitrust remedies can be effective in this case, because clearly no collusive conduct can be demonstrated when firms set high prices without coordinating their actions. There seems to be no obvious solution to this problem. Perhaps, regulating prices is currently the only available measure to improve consumer welfare in this particular situation.

A second main finding is that high price equilibria may exist for all values of the discount factor (Scenario 1–a). This occurs when buyers are sufficiently inert or when the number of customers that can be gained by cutting price is limited. Hence, the market situation and consumer characteristics might be such that firms always have a possibility to sustain high prices. This can potentially be remedied by lowering the degree of consumer inertia. Theorem 5 shows that, *ceteris paribus*, by increasing $p$ (the likelihood that a price reduction results in attracting more consumers), we may end up in Scenario 2–a; a state in which high prices cannot be sustained for high levels of the discount factor. Thus, our analysis indicates that it may be worthwhile to take measures that result in less demand viscosity. For instance, our findings provide some support for decisions that lead to more price transparency and short-term contracts.[11] If such measures are successful and firms are sufficiently patient, then this may provide them with an incentive to charge low prices.

We furthermore find that, under certain conditions, high prices cannot be sustained for moderate values of the discount factor, while these would be sustainable for more extreme values of the discount factor. This can occur only when the industry exhibits network effects or when there is a lack of a common standard. The fact that the ability of firms to maintain high prices can depend non-monotonically on the level of the discount factor may have some

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[11]Note, however, that increasing price transparency may have adverse effects when it allows firms to better observe the transaction prices of their rivals. See Albaek, Mollgaard and Overgaard (1997) in which it is suggested that the publication of firm-specific transaction prices in Danish markets for concrete led to a significant increase in prices.

important implications. For example, suppose that an economy-wide restriction on long-term contracts is introduced in order to reduce the level of consumer inertia. Although this can have a beneficial effect in some markets for reasons described above, it potentially helps firms to escape from Scenario b and bring them into Scenario a. Consequently, measures that aim to lower the degree of consumer inertia can have adverse effects and, in fact, facilitate collusion.

It is important to realize that the applicable scenarios are partly endogenous. That is to say, both the parameters $p$ and $s$ can to some extent be influenced by firms and therefore can potentially be used to facilitate collusion.[12] For example, if firms are very patient and find themselves in Scenario 2–a, then they could try to enhance consumer inertia (*e.g.*, take measures to increase switching costs). This may bring them into Scenario 1–a in which high prices can be supported as a subgame perfect equilibrium. Depending on the magnitude, measures increasing consumer inertia may even create a situation in which high prices become sustainable in stationary strategies, which means that no coordination of actions is required to get the most profitable market outcome. Similarly, if firms find themselves in the "non-monotonic area" of Scenario b, then they can try to affect the degree of consumer inertia to end up in Scenario a in which the non-monotonicity is absent. Observe that, in this case, an increase as well as a decrease in the level of consumer inertia can have the desired effect. Hence, firms may implement apparently pro-competitive measures that reduce the level of consumer inertia, with the sole purpose to create a situation in which high prices can be sustained.

These considerations imply that there are distinct possibilities for firms to benefit from communication in markets where buyers are inert. In particular, agreeing to influence demand inertia might be equally effective, but easier to arrange and less conspicuous than a price-fixing agreement. Arguably, changing the level of consumer inertia is more effective than direct price fixing as it alters the incentives of firms to set a high or a low price. This type of strategy can be especially beneficial in markets with network effects, because in those markets it is most rewarding to acquire a dominant market position by becoming the standard. At the same time, however, the presence of demand viscosity may provide an explanation for why firms sometimes choose to explicitly discuss prices, which makes them subject to antitrust enforcement. The standard model of collusion suggests that there is no real need for talking about prices as any collusive outcome can be explained as resulting from a tacit coordination of actions. However, if antitrust enforcement makes collusion costly, but not too costly, then

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[12]See, for instance, Genesove and Mullin (2001) who describe how the Sugar Cartel in the U.S. (1927-1936) colluded on various business practices so as to facilitate price collusion.

it may effectively function as a commitment device.[13] That is, the risk of a fine or even a prison sentence makes short-term profits relatively more important and if demand is viscous, then these short-term gains are maximized by setting high prices. This argument is formally illustrated in Appendix A. In sum, our findings suggest that it might be more fruitful for society to try to affect firms' incentives by changing levels of consumer inertia rather than to punish behavior caused by adverse incentives.

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[13]McCutcheon (1997) also shows that antitrust enforcement may have adverse effects when it makes collusion costly, but not too costly, but for a different reason. This paper argues that the expected costs created by antitrust law enforcement may prevent renegotiations in case of defection. Hence, antitrust may help in making the punishment strategy credible, thereby facilitating collusion.

# Appendix A: Explicit Collusion

The difference between tacit and explicit collusion is an issue that has puzzled economists already for quite a while.[14] In the standard model of collusion – the infinitely repeated prisoner's dilemma – every collusive outcome can be explained as a consequence of a tacit coordination of actions. Hence, according to the theory of industrial collusion, there is no real need for firms to explicitly discuss their pricing policies. Yet, there is an abundance of evidence from antitrust practice that a great many firms decided to talk about prices. In the following, we show how the presence of demand viscosity can explain the added value of direct communication about prices.

Suppose that communication between firms is detected with probability $\alpha$ and, once detected, is sanctioned with a fine of size $F$ to be paid to the antitrust authority. We assume that the possibility of getting caught exists after periods in which at least one firm set the high collusive price. Moreover, we assume that after discovery of the price-fixing agreement firms are strictly monitored so that low prices are set in all future periods. We will show that the presence of this type of antitrust enforcement can make high prices sustainable, while these cannot be sustained without such measures.

First, suppose firms communicate. One can show that high prices are sustainable in trigger strategies if and only if

$$\frac{1}{1-(1-\alpha)\,\delta}\left(s\,h + \alpha\,\delta\left[\frac{s\,\ell}{1-\delta} - F\right]\right) \;\geq\; s\,\ell + (1-\alpha)\,\delta\left[p\frac{h}{1-\delta} + (1-p)\frac{s\,\ell}{1-\delta}\right] + \alpha\,\delta\left[\frac{s\,\ell}{1-\delta} - F\right].$$

For $\alpha = 0$ this inequality simplifies to $\delta \leq \frac{s\,(h-\ell)}{p\,(h-s\,\ell)}$, which is equivalent to the condition for high prices to be sustainable without direct communication (see Proposition 3). As we analyze when high prices become sustainable when communication is introduced, we assume this inequality to be violated. Yet, for $\alpha = 1$ the inequality simplifies to $s\,(h - \ell) \geq 0$, which is always satisfied. From this we can conclude that there exists a lower bound on the probability of being caught above which high prices are sustainable. Hence, external monitoring may provide firms with an incentive to abide by the collusive agreement.

Second, in the presence of antitrust enforcement, communication is profitable if and only if

$$\frac{1}{1-(1-\alpha)\,\delta}\left(s\,h + \alpha\,\delta\left[\frac{s\,\ell}{1-\delta} - F\right]\right) \;\geq\; \frac{s\,\ell}{1-\delta} \quad \Longleftrightarrow \quad s\,(h-\ell) \geq \alpha\,\delta\,F.$$

Thus, communication is beneficial if and only if the per-period benefit of collusion exceeds the expected fine. So, if the probability of getting caught is sufficiently high and the fine $F$

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[14]See, for example, Whinston (2006) for a discussion on this issue.

is sufficiently low, explicit collusion can be an equilibrium in a model with consumer inertia, whereas tacit collusion may be infeasible.

It remains to be shown that antitrust enforcement can not be used as a commitment device in the standard model of collusion. To that end, assume that high prices are not sustainable in equilibrium in an infinitely repeated prisoner's dilemma without communication. That is, assume that $\delta < \frac{\pi^d - \pi^c}{\pi^d - \pi^n}$, where $\pi^c$, $\pi^d$ and $\pi^n$ represent the one-shot profits associated with collusion, unilateral deviation and competition respectively (with $\pi^d > \pi^c > \pi^n$). When firms choose to communicate directly, high prices are sustainable if and only if

$$\frac{1}{1-(1-\alpha)\,\delta}\left(\pi^c + \alpha\,\delta\left[\frac{\pi^n}{1-\delta} - F\right]\right) \geq \pi^d + (1-\alpha)\,\delta\,\frac{\pi^n}{1-\delta} + \alpha\,\delta\left[\frac{\pi^n}{1-\delta} - F\right].$$

For $\alpha = 0$ this inequality simplifies to $\delta \geq \frac{\pi^d - \pi^c}{\pi^d - \pi^n}$ and for $\alpha = 1$ to $\pi^c \geq \pi^d$. The condition for high prices to be sustainable is not satisfied for these two extreme values of $\alpha$ and it can be easily verified that the condition is not satisfied for any $\alpha$ in $[0, 1]$. Hence, in the standard model of collusion talking about prices cannot induce high prices to become sustainable.

# Appendix B: Proofs

**Proof of Proposition 1.** For the proof we make use of the well-known property that a firm always has a stationary best response against a rival adopting a stationary strategy. Given that the rival adopts the stationary high price strategy, the present value of the profits that results from responding with the stationary strategy that prescribes to select the high respectively the low price is given by:

$$V_H = s\,h + \delta\,V_H \quad \text{and} \quad V_L = s\,\ell + \delta\,\{\, p\,\tfrac{h}{1-\delta} + (1-p)\,V_L \,\}.$$

High prices are sustainable as a stationary subgame perfect equilibrium if and only if the stationary high price strategy is a best response. This is the case when

$$V_H \geq V_L \quad \Longleftrightarrow \quad \tfrac{s\,h}{1-\delta} \geq \tfrac{(1-\delta)\,s\,\ell + \delta\,p\,h}{(1-\delta)(1-\delta\,(1-p))} \quad \Longleftrightarrow \quad \delta \leq \tfrac{s\,(h-\ell)}{s\,(h-\ell) + p\,(1-s)\,h}.$$

$\square$

**Proof of Proposition 2.** Suppose that the rival adopts the stationary low price strategy. Responding with the stationary low price strategy is optimal if and only if

$$\tfrac{s\,\ell}{1-\delta} \geq \tfrac{s\,h}{1-\delta\,(1-p)} \quad \Longleftrightarrow \quad \delta \geq \tfrac{h-\ell}{h-\ell+p\,\ell}.$$

Consequently, the optimal response is to adopt the stationary high price strategy when $\delta < \tfrac{h-\ell}{h-\ell+p\,\ell}$.

$\square$

**Proof of Proposition 3.** Suppose $\delta \geq \delta_L$ and the rival adheres to the trigger strategy. Then, the present value of adhering to the trigger strategy equals $\tfrac{s\,h}{1-\delta}$, while a deviation generates a present value of $s\,\ell + \delta\,\{\, p\,\tfrac{h}{1-\delta} + (1-p)\,\tfrac{s\,\ell}{1-\delta} \,\}$. It can be easily verified that deviating is not profitable if $\delta < \delta_{LL}$.

Suppose now that $\delta_H < \delta < \delta_L$ and the rival adheres to the trigger strategy. Then, the present value of adhering to the trigger strategy equals $\tfrac{s\,h}{1-\delta}$, while deviating to the low price generates a present value of $s\,\ell + \delta\,\{\, p\,\tfrac{h}{1-\delta} + (1-p)\,\tfrac{s\,h}{1-(1-p)\,\delta} \,\}$. It can be easily verified that deviating is not profitable if $\delta$ is such that

$$(1-p)\,[s\,(h-\ell)+p\,h]\cdot\delta^2 - [2\,(1-p)\,s\,(h-\ell)+p\,(h-s\,\ell)]\cdot\delta + s\,(h-\ell) \geq 0.$$

This quadratic inequality is satisfied when $\delta$ is smaller than $\delta_{LH}^-$ or larger than $\delta_{LH}^+$.

$\square$

**Proof of Theorem 4 and Theorem 5.** We prove both theorems along the following lines. First, we provide the conditions that determine whether the model is in Scenario 1 or in Scenario 2. Next, the conditions that distinguish scenario a and b are derived. Finally, we show – after illustrating the conditions graphically – that all combinations of conditions are compatible. More precisely, we show that, for each $h$ and $\ell$, there exist values of $p$ and $s$ such that the conditions are met.

**Scenario 1 and 2.** The only condition that needs to be satisfied for the model to be in Scenario 1 is $\delta_{LL} > 1$; or, $p < \frac{s\,(h-\ell)}{h-s\,\ell}$. Otherwise, the model is in Scenario 2.

**Scenario a and b.** There are three conditions that need to be satisfied for the model to be in Scenario b: (1) $\delta_{LH}^-, \delta_{LH}^+ \in \mathbb{R}$; (2) $\delta_{LH}^- < \delta_L$; and (3) $\delta_{LL} > \delta_L$.

*Condition (1).* Without the first condition the intersection of $(\delta_{LH}^-, \delta_{LH}^+)$ with $(\delta_H, \delta_L)$ is guaranteed to be nonempty. This condition is satisfied if and only if $p \geq \frac{4\,h\,s^2\,(h-\ell)}{4\,h\,s^2\,(h-\ell)+(h-s\,\ell)^2}$.

*Condition (2).* It can be easily verified that, whenever the first condition is satisfied, $\delta_{LH}^+ \geq \delta_{LH}^- > \delta_H$. The second condition guarantees that the earlier intersection is nonempty, and hence there is a range of discount factors in $(\delta_H, \delta_L)$ for which high prices are not sustainable. This condition is satisfied if and only if

$$[h - \ell + p\,\ell]\sqrt{[2\,(1-p)\,s\,(h-\ell) + p\,(h - s\,\ell)]^2 - 4\,(1-p)\,s\,(h-\ell)\,[s\,(h-\ell) + p\,h]}$$
$$> \quad p\,(h - s\,\ell)[h - \ell + p\,\ell] - 2\,p\,(1-p)\,(h-\ell)\,(h - s\,\ell).$$

This inequality is certainly satisfied when the right hand side is negative, *i.e.*, $p < \frac{h-\ell}{2\,h-\ell}$. Suppose next that the right hand side is positive. Then, with some effort, the inequality can be rearranged to $p\,(h - 2\,s\,\ell) > s\,(h-\ell)$.

*Condition (3).* The third condition warrants that there is range of discount factors just above $\delta_L$ for which high prices are sustainable by means of trigger strategies. By continuity of the present values it follows that this condition implies that there is also a range of discount factors just below $\delta_L$ for which high prices are sustainable. Hence, this condition implies $\delta_{LH}^+ < \delta_L$. This condition is satisfied if and only if $p\,(h - 2\,s\,\ell) < s\,(h-\ell)$.

Notice that the second and third condition are incompatible when $p > \frac{h-\ell}{2\,h-\ell}$. From this it can be concluded that Scenario b can only occur when $p < \frac{h-\ell}{2\,h-\ell}$.

**Graphical representation of conditions.** Figure 4 plots the relevant curves. Curve $c.1$ plots precisely the parameter values separating Scenario 1 and 2: $p = \frac{s\,(h-\ell)}{h-s\,\ell}$. The other three curves – $c.2$, $c.3$ and $c.4$ – enclose Scenario b. First, curve $c.2$ plots the values of $p$ above which condition (1) is satisfied; that is, $p = \frac{4\,h\,s^2\,(h-\ell)}{4\,h\,s^2\,(h-\ell)+(h-s\,\ell)^2}$. Next, curve $c.3$ plots the values of $p$ below which condition (2) is satisfied, while enabling compatibility of condition (2) and (3):
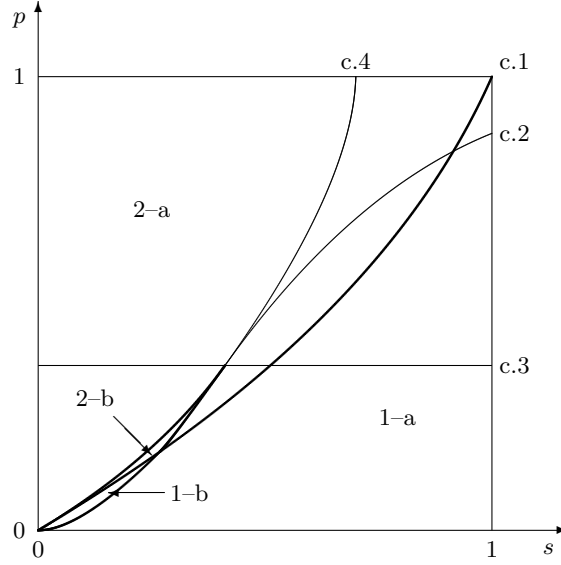
Figure 4: Relation between parameters and scenarios.

$p = \frac{h-\ell}{2\,h-\ell}$. Finally, curve $c.4$ captures the condition $p\,(h - 2\,s\,\ell) < s\,(h - \ell)$. For $s \geq \frac{h}{2\,\ell}$ this condition is satisfied for all values of $p$. For lower values of $s$ it requires $p < \frac{s\,(h-\ell)}{h-2\,s\,\ell}$. Curve $c.4$ plots the values for which $p = \frac{s\,(h-\ell)}{h-2\,s\,\ell}$. All values of $p$ and $s$ to the south-east of this curve, and only these values, are compatible with condition (3).

**Non-emptiness of the areas.** Suppose for the moment that $s < \frac{h}{2\,\ell}$. Curve $c.2$ is below curve $c.4$ if and only if $(2\,h + \ell)^2\,s^2 - 2\,h\,(2\,h + \ell)\,s + h^2 > 0$, which is satisfied for all $s$ except for $s = 0$ and $s = \frac{h}{2\,h+\ell}$. At the latter point the two curves are tangent to each other, and the corresponding value of $p$ at this point is $\frac{h-\ell}{2\,h-\ell}$. Hence, both curves intersect curve $c.3$ at precisely this point. Notice that this is at a value of $s$ below $\frac{h}{2\,\ell}$, which is in agreement with our supposition. This guarantees non-emptiness of Scenario b. Next, non-emptiness of the area 2–b results from curve $c.1$ being below curve $c.4$ with exception of the origin. Finally, non-emptiness of the area 1–b follows from the slope of curve $c.2$ being less than the slope of curve $c.1$ at the origin: $0 < \frac{h-\ell}{h}$.

$\square$

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