Dynamic Vertical Collusion with Secret Contracts

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Abstract: We show that secret vertical contracts between a supplier and retailers can facilitate collusion in a dynamic game when competing retailers and their joint supplier all care about future profits. The more the retailers and the supplier care about future profits, retailers obtain a higher share of the monopoly profits. We also find that sustaining collusion requires retailers to commit to deal exclusively with the joint supplier and to charge slotting allowances. Hence, slotting allowances facilitate downstream collusion even when retailers do not observe their rivals' contracts with the supplier. Also, the dynamic game can enable the supplier to charge a higher wholesale price even when retailers have the bargaining power.

Keywords: vertical relations, tacit collusion, opportunism, slotting allowances

JEL Classification Numbers: L41, L42, K21, D8

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1. Introduction

This paper asks whether and how competing retailers can use a joint supplier to help them collude over the price the retailers charge consumers, in the common case where a retailer cannot observe the rival retailer's contract with the supplier. Often, in a certain geographic area, retailers fiercely compete over end consumers. Retailers would prefer to collude at the expense of consumers, but competition among them is often too intense to support such collusion. When retailers observe each other’s contract with the supplier, they can be discouraged from deviating from collusion if the supplier raises the wholesale price it charges retailers. If a retailer attempts to persuade the supplier to grant it a discount, in order to deviate from the collusive scheme, the competing retailer observes this and reacts immediately, thereby deterring the first retailer from deviating. But normally, vertical contracts between suppliers and retailers are not publicly observable, so one retailer does not know whether the supplier granted a secret discount to a competing retailer. Such a secret discount encourages a retailer to deviate from a collusive scheme. Thus, supposedly, in the case of secret vertical contracts, retailers would hesitate to collude in the first place. Also, when the supplier is tempted to make such secret price cuts in favor of one retailer at the expense of the other retailer, even the supplier of a strong brand finds it difficult to commit to charging a high wholesale price. The incentive of the supplier and the retailer to agree on a secret discount is exacerbated when retailers have considerable bargaining power vis-à-vis the supplier and when retailers compete with each other fiercely.[1]

The main result of our paper is that even secret vertical contracts between retailers and their joint supplier can facilitate collusion among retailers in a dynamic game when the retailers and their joint supplier are strategic players who all care about future profits. In such a situation, the supplier is willing and able to aid retailers' collusion even though vertical contracts are secret. The collusive scheme enables the supplier to charge higher wholesale prices. Hence, even though retailers do not observe the supplier's price cuts to one retailer at the expense of the other, the supplier himself has an incentive to police its own and retailers' adherence to the collusive scheme. The supplier pays the retailers “slotting allowances” (fixed fees paid by suppliers to retailers in exchange for shelf space, promotional activities, and the like) to induce them to collude. Retailers refrain from deviating from collusion, because then

[1] In recent years, large multi-branch retailers have been gaining considerable bargaining power vis-à-vis suppliers. Because such retailers have national coverage and access to an extremely large customer base, suppliers, even those with powerful brands, cannot afford not to be present on retailers' shelves. See, e.g., OECD (2013); Consumers International, The relationship between supermarkets and suppliers: What are the implications for consumers?, http://www.consumersinternational.org/media/1035307/summary,%20the%20relationship%20between%20supermarkets%20and%20suppliers.pdf (last visited in January 2016). Many of these suppliers are multi-brand suppliers and not all of their brands are as strong. This can raise suppliers' dependency on supermarket chains.

they would sacrifice the future slotting allowances they would have received from the supplier. Without such slotting allowances, the collusive scheme collapses, since then retailers cannot share collusive profits with the supplier, and they prefer deviating from the collusive scheme. Interestingly, slotting allowances paid to supermarket chains are a widespread phenomenon. According to analysts, American retailers make more than $18 billion in slotting allowances each year. In the UK, it is estimated that the big four supermarkets receive more in payments from their suppliers than they make in operating profits, and in Australia, it has been reported that growing supplier rebates have boosted food retailers' profit margins by an average of 2.5 percentage points, to 5.7%, over the past five years. It was further reported that this phenomenon is not associated with low retail prices (The Economist, 2015).[2] An EC study examining slotting allowances in the different European member states reports over 500 "excuses" for the payment of such fees by suppliers to retailers, in addition to merely paying for shelf space.[3]

Our model includes two competing retailers and a joint monopoly supplier in an infinitely repeated game, when all three firms care about the future (we later ask whether the result carries over to the case of competition among suppliers). In every period retailers offer take-it-or-leave-it secret two-part-tariff contracts to the supplier and then compete in prices. The contracts are secret such that a retailer can never know, not even at the end of the period, what was the contract that the competing retailer offered the supplier. Moreover, at the pricing stage, a retailer cannot observe whether the competing retailer and the supplier signed a contract. At the end of the period retailers can only observe the retail prices of the competing retailers, if indeed they carried the supplier's product.

We solve for an infinitely repeated collusive equilibrium. In every period the two retailers offer a two-part-tariff contract that motivates them to collude on the monopoly price without observing the contract of the supplier and the competing retailer. This raises the potential for opportunistic behavior: by a retailer, who can offer the supplier a different contract than the equilibrium one and then undercut the monopoly price, or by the supplier, who can reject the equilibrium contract of one of the retailers.

Our base model considers undifferentiated retailers. We find that for any positive discount factor, there is an equilibrium in which retailers collude on the monopoly price and earn positive profits, even though they are homogeneous. To encourage the supplier to police and maintain collusion, retailers share collusive profits with the supplier, despite their bargaining power. The more firms care about the future, retailers can maintain a higher share of collusive profits, at the expense of their joint supplier. We also find that the equilibrium

[2] Notably, The Economist (2015) also reports that Walmart, known for heavy discount pricing, does not collect slotting allowances from suppliers.
[3] See Stichele, Vander and Young (2008).

contract involves a wholesale price above the supplier's marginal costs and negative fees in the form of slotting allowances. The level of slotting allowances is non-monotonic in the firms' discount factor: the more firms care about future profits, the level of slotting allowances first increases and then decreases.

We then show that the existence of a competing supplier causes the collusive scheme to break down. In real life, retailers can restore their ability to collude if they make a long-term commitment to buy exclusively from one of the suppliers. We show, however, that repeated interaction in itself cannot help sustain such exclusivity. When one retailer tries to commit to buy exclusively from one supplier, the other retailer has an incentive to deviate from the collusive scheme by buying from the competing supplier. Still, competing retailers may often be able to commit to purchase exclusively from the same supplier via some external commitment mechanism. For example, a dominant supplier may be made "category captain", and use its position to exclude the other suppliers from retailers' shelves.[4] Also, one of the suppliers may have some inherent advantage. For example, it may offer a product that retailers must have. When retailers must purchase a portion of their requirements from a particular supplier, retailers can be induced to operate solely with this supplier via loyalty rebates.[5] Also, retailers may be tied to a particular supplier due to relationship-specific investments or rival suppliers' capacity constraints.

We then extend our base model to the case of differentiated retailers. We find that in this case too secret vertical contracts that include slotting allowances facilitate collusion in that they enable the retailers and their joint supplier to maintain a collusive equilibrium for a larger range of discount factors. Unlike in the case of homogenous retailers, however, the three firms cannot use vertical contracts to sustain collusion for any discount factor: when they are too short sighted, i.e., when their discount factor is too small, they cannot maintain collusion even when using vertical contracts. We find that the less differentiated retailers are, the more they can use secret vertical contracts to sustain collusion even for low discount factors.

Our results have several policy implications. We show that slotting allowances (or actually any fixed fee paid by suppliers to downstream firms, regardless of what it is paid for) may be used to eliminate downstream competition even in the common case where the

[4] See, e.g. Conwood Co LP v US Tobacco Co, 290 F.3d 768, *cert. denied*, U.S. Tobacco Co. v. Conwood Co., L.P., 537 U.S. 1148, Jan. 13, 2003 (where a dominant supplier of moist snuff, a type of chewing tobacco, served as category captain of most retailers and used its position, in addition to payment of slotting allowances and fees for placing exclusive racks in stores, to exclude rivals from retailers' shelves and raise prices); Church & Dwight Co., Inc. v. Mayer Laboratories, Inc., 2011 WL 1225912 (n.d.cal.), vacated by Church & Dwight Co. INC. v. Mayer Laboratories, INC. 868 F.Supp.2d 876, (N.D. California 2012). (where a dominant supplier of condoms was elected as category captain of several leading retail chains, while also paying them slotting allowances and signing exclusive dealing agreements).

[5] See, e.g., Nalebuff (2005).

vertical contract between the supplier and a retailer is unknown to the competing retailer. This implies that slotting allowances deserve stricter antitrust treatment than currently believed. The antitrust case law to date very rarely condemns slotting allowances, and focuses only on the concern that they will exclude the supplier's rivals from retailers' shelves. By contrast, we show that as long as a supplier maintains its dominance in some way, the fees themselves need not have any exclusionary effect on rival suppliers for them to harm competition. Furthermore, the anticompetitive effect of slotting allowances is unaffected by the number of competing retailers. It is the concentrated structure of the supply market that matters. Our results imply what an antitrust agency should be looking for when it assesses the anticompetitive harm stemming from a slotting allowance. In particular, we find that the anti-competitive effect of slotting allowances is not necessarily related to their size. Even when firms hardly care about future profits, although it should be very difficult for them to collude, still a small slotting allowance is enough to enable collusion. When firms discount the future at a moderate level, implying that collusion is relatively easier to sustain, the size of slotting allowances needed to support collusion is actually at its peak. Furthermore, when the antitrust authority finds that slotting allowances were paid as compensation for intense competition among retailers, our results imply that such scenarios may deserve more lenient antitrust treatment, since according to our results slotting allowances serve as prizes the supplier pays retailers for colluding. Another characteristic of slotting allowances that have the anticompetitive nature we identify is that they take the form of fixed payments rather than per-unit discounts.

We show that when the supplier faces aggressive competition from other suppliers, slotting allowances can no longer facilitate downstream collusion, thereby justifying more lenient antitrust treatment of slotting allowances in such cases. Conversely, the paper shows that when competing retailers manage to make a long-term commitment to exclusive dealing arrangements with one supplier, in conjunction with the use of slotting allowances, this can not only exclude other suppliers, but also facilitate collusion among retailers. We show, however, that such exclusivity cannot be supported by retailer's collusion and repeated interaction itself – there must be some external mechanism committing both retailers to buy exclusively from the same supplier.

The results also imply that the "Chicago School" approach advocating lenient treatment of vertical restraints that eliminate downstream competition may not be justified. Also, resale prices dictated or suggested by suppliers may equal the monopoly retail price, to the detriment of consumers, rather than at a level merely stimulating efficiencies in distribution. The supplier in our model pays the retailers slotting allowances and hence its profits stem solely from the wholesale price it charges. It allegedly follows, according to the "Chicago School's" approach, that the supplier would want retail prices to be as low as possible, to maximize the number of units sold. Our results, however, imply that the supplier may want to dictate or suggest to the retailers to charge the monopoly retail price, since this is what drives the vertical collusive scheme.

Our paper is related to several strands of the economic literature. The first strand concerns literature on static games in which vertical contracts serve as a devise for reducing price competition between retailers. Bonanno and Vickers (1988) consider vertical contracts when suppliers have the bargaining power and offer contracts to their retailers. They find that suppliers use two-part tariffs that include a wholesale price above marginal cost in order to relax downstream competition, and a positive fixed fee, to collect the retailers' profits. Shaffer (1991) and (2005), Innes and Hamilton (2006), Rey, Miklós-Thal and Vergé (2011) and Rey and Whinston (2012) consider the case where retailers have buyer power. In such a case, retailers pay wholesale prices above marginal cost in order to relax downstream competition and suppliers pay fixed fees to retailers.

The above literature suggests that slotting allowances may relax downstream competition.[6] However, as Shaffer (1991) points out, slotting allowances in the above-mentioned frameworks can relax competition only when vertical contracts are observable. The main contribution of our paper to this literature is by considering slotting allowances within a dynamic game rather than a static game and considering the common case where vertical contracts are unobservable to retailers rather than observable. Importantly, exchange of information among retailers competing in a downstream market regarding the terms of their contracts with a supplier is an antitrust violation.[7]

The second strand of literature involves static vertical relations in which a supplier behaves opportunistically by granting price concessions to one retailer at the expense of the other. Hart and Tirole (1990), O'Brien and Shaffer (1992), McAfee and Schwartz (1994) and

[6] At the same time, Chu (1992), Lariviere and Padmanabhan (1997), Desai (2000) and Yehezkel (2014) show that slotting allowances may also have the welfare enhancing effect of enabling suppliers to convey information to retailers concerning demand. See also Federal Trade Commission (2001, 2003), and European Commission (2012) discussing some of the pro's and con's of slotting allowances.

[7] See Department of Justice/Federal Trade Commission (2000) (stressing that the exchange of current or future, firm specific, information about costs is most likely to raise competitive concerns); European Commission (2011) ("the exchange of commercially sensitive information such as purchase prices and volumes … may facilitate coordination with regard to sales prices and output and thus lead to a collusive outcome on the selling markets"); Federal Trade Commission (2011) ("If the information exchanged is competitively sensitive—that is, if it is information that a company would not normally share with its competitors in a competitive marketplace, such as … supplier or cost information … or other similar information—companies should establish appropriate firewalls or other safeguards to ensure that the companies remain appropriately competitive throughout their cooperation."); OECD (2010) (discussing an antitrust case brought by the South African Competition Commission and condemning information exchanges among competing buyers of raw milk regarding the prices paid to suppliers as a violation of the section forbidding illegal agreements); New Zealand Commerce Commission (2014) (warning that information exchanges such as "… discussing supplier interactions with a competitor create an environment in which anti-competitive agreements or conduct can easily emerge. This creates significant risk for the parties involved, including employees. Such exchanges and discussions should be avoided."

Rey and Verg´e (2004) consider suppliers that make secret contract offers to retailers. They find that a supplier may behave opportunistically (depending on the retailers' beliefs regarding the supplier's offer to the competing retailers) and offer secret discounts to retailers. Anticipating this, retailers will not agree to pay high wholesale prices and the supplier cannot implement the monopoly outcome. We contribute to this strand of literature by showing that a dynamic game can resolve the opportunism problem and restore the supplier's power to charge high wholesale prices. If a supplier and one of the retailers in our model behave opportunistically in a certain period, the competing retailer stops cooperating in the next periods. Since the two retailers and the supplier all care about future profits, this serves as a punishment against opportunistic behavior.

The third strand of literature involves vertical relations in a dynamic, infinite horizon collusive game. Schinkel, Tuinstra and Rüggeberg (2007) consider collusion in vertical relations when suppliers can forward some of the collusive profits to downstream firms in order to avoid private damages claims. Normann (2009) and Nocke and White (2010) find that vertical integration can facilitate collusion between a vertically integrated firm and independent retailers. Piccolo and Reisinger (2011) find that exclusive territories agreements between suppliers and retailers can facilitate collusion. Piccolo and Miklós-Thal (2012) show that retailers with bargaining power can collude by offing perfectly competitive suppliers a high wholesale price and negative fixed fees. Doyle and Han (2012) consider retailers that can achieve the monopoly outcome by forming a buyer group that jointly offers contracts to suppliers. The above literature focused on the case where information concerning vertical contracts is either publicly observable or can be credibly conveyed by retailers to competing retailers. It shows that the collusive outcome can be achieved in the above frameworks only where each retailer can observe the competing retailer's contract with the supplier. Our contribution to the above literature is that we focus on secret vertical contracts that cannot be observed, nor conveyed, to competing retailers. In our framework, in which the supplier as well as retailers care about the future, the collusive outcome can be sustained even when vertical contracts are secret.

The most closely related papers to ours concern dynamic collusion in vertical relations when vertical contracts are secret. Nocke and White (2007) consider collusion among upstream firms and the effect vertical integration has on such collusion. In an appendix, they also analyze secret vertical contracts. In their framework, however, retailers are not concerned with their rivals' vertical contracts, because they decide whether to accept suppliers' offers only after they observe their rivals' retail prices. Our paper focuses on whether secret vertical contracts facilitate collusion among downstream firms. Hence, we assume retailers set their prices only after their secret contract with the supplier is reached. Jullien and Rey (2007) consider an infinite horizon model with competing suppliers that offer retailers secret contracts. Their paper studies how suppliers can use resale price maintenance to facilitate collusion among the suppliers, in the presence of stochastic demand shocks. There are three main differences between their model and ours. First, we do not consider demand shocks, which are the main focus of their paper. Second, Jullien and Rey (2007) assume that each supplier serves a different retailer, while we consider two retailers that buy from a joint supplier. Third, they assume that retailers are myopic while suppliers care about future profits. In our paper all three firms – the two retailers and their joint supplier – care about the future. Because of these features, in which both retailers buy from a joint supplier and both retailers and the supplier care about the future, the collusive equilibrium in our model involves dividing the monopoly profit among all three firms. Under such profit sharing, all three firms – the supplier and both retailers -- have an incentive to maintain the collusive equilibrium. Reisinger and Thomes (2015) consider dynamic competition between two competing and long-lived manufacturers that have secret contracts with short-lived retailers. They find that colluding through independent, competing retailers is easier to sustain and more profitable to the manufacturers than colluding through a joint retailer. Our paper focuses on downstream collusion rather than upstream collusion, and assumes that both the supplier and the two retailers care about future profits. We find that vertical relations can facilitate downstream collusion when both retailers buy from the same supplier.

2. The model

Consider two downstream retailers, R_1 and R_2 that compete in prices. In our base model, we focus on the extreme case where retailers are homogeneous. Doing so enables us to deliver our main results in a clear and tractable manner. In section 5, we show that the qualitative results of the base model extend to markets with differentiated retailers.

Retailers can obtain a homogeneous product from an upstream supplier. Production and retail costs are zero. Consumers' demand for the product is $Q(p)$, where p is the final price and $pQ(p)$ is concave in p. Let p^* and Q^* denote the monopoly price and quantity, where p^* maximizes $pQ(p)$ and $Q^*=Q(p^*)$. The monopoly profit is p^*Q^*.

The two retailers and the supplier interact for an infinite number of periods and have a discount factor, δ, where $0 \leq \delta \leq 1$. The timing of each period is as follows:

- *Stage 1*: Retailers offer a take-it-or-leave-it contract to the supplier (simultaneously and non-cooperatively). Each R_i offers a contract (w_i, T_i), where w_i is the wholesale price and T_i is a fixed payment from R_i to the supplier that can be positive or negative. In the latter case the supplier pays slotting allowances to R_i. The supplier observes the offers and decides whether to accept one, both or none. All of the features of the bilateral contracting between R_i and the supplier are unobservable to R_j ($j \neq i$) throughout the game. Moreover, R_i cannot know whether R_j signed a contract with the supplier until the end of the period, when retail prices are observable. The contract offer is valid for the current period only.[8]

- *Stage 2*: The two retailers set their retail prices for the current period, p_1 and p_2, simultaneously and non-cooperatively. Consumers buy from the cheapest retailer. In case $p_1 = p_2$, each retailer gains half of the demand. At the end of the stage, retail prices become common knowledge (but again retailers cannot observe the contract offers). If in stage 1 the supplier and R_j didn't sign a contract, R_i only learns about it at the end of the period, when R_i observes that R_j didn't set a retail price for the supplier's product (or equivalently charged $p_j = \infty$). Still, R_i cannot know why R_j and the supplier didn't sign a contract (that is, R_i doesn't know whether the supplier, R_j, or both, deviated from the equilibrium strategy).

We consider pure-strategy, perfect Bayesian-Nash equilibria. We focus on symmetric equilibria, in which along the equilibrium path both retailers choose the same strategy, equally share the market and earn identical profits. We allow an individual retailer to deviate unilaterally outside the equilibrium path.

When there is no upstream supplier and the product is available to retailers at marginal costs, retailers only play the second stage in every period, in which they decide on retail prices, and therefore the game becomes a standard infinitely-repeated Bertand game with two identical firms. Then, a standard result is that collusion over the monopoly price is possible if:

$$\frac{p^*Q^*\frac{1}{2}}{1-\delta} > p^*Q^* \quad \Leftrightarrow \quad \delta > \tfrac{1}{2},$$

where the left hand side is the retailer's sum of infinite discounted profit from colluding on the monopoly price and gaining half of the demand and the right hand side is the retailer's profit from slightly undercutting the monopoly price and gaining all the demand in the current period, followed by a perfectly competitive Bertrand game with zero profits in all future periods. Given this benchmark value of $\delta = 1/2$, we ask how vertical relations – the retailers' ability to sign two-part-tariff contracts with a joint supplier – affect the retailers' ability to collude, when one retailer's two-part-tariffs are unobservable to the competing retailer throughout the game and both retailers and the supplier care about future profits.

[8] See Piercy (2009), claiming that large supermarket chains in the UK often change contractual terms, including the wholesale price and slotting allowances, on a regular basis, e.g., via e-mail correspondence; Lindgreen, Hingley and Vanhamme (2009), discussing evidence from suppliers regarding large supermarket chains dealing with them without written contracts and with changing price terms; See also "How Suppliers Get the Sharp End of Supermarkets' Hard Sell, The Guardian, http://www.theguardian.com/business/2007/aug/25/supermarkets.

3. Competitive static equilibrium benchmark

In this section we solve for a competitive equilibrium benchmark in which the three firms have $\delta = 0$. This can also be an equilibrium when $\delta > 0$ and the three firms expect that their strategies in the current period will not affect the future. This benchmark is needed for our analysis because we will assume that an observable deviation from collusion will result in playing the competitive equilibrium in all future periods. The main result of this section is that in the static game price competition dissipates all of the retailers' profits. Moreover, since contracts are secret and the supplier has an incentive to act opportunistically, there are equilibria in which the supplier earns below the monopoly profits.

In a symmetric equilibrium, in stage 1 both retailers offer the contract (T^C, w^C) that the supplier accepts. Then, in stage 2, both retailers set p^C and equally split the market. Each retailer earns $(p^C - w^C)Q(p^C)/2 - T^C$ and the supplier earns $w^C Q(p^C) + 2T^C$. Since vertical contracts are secret, there are multiple equilibria, depending on firms' beliefs regarding off-equilibrium strategies. In what follows, we characterize the qualitative features of these equilibria.

First, notice that in any such equilibrium, $p^C = w^C$ because in the second stage retailers play the Bertrand equilibrium given w^C. Therefore, there is no competitive equilibrium with $T^C > 0$, because retailers will not agree to pay a positive fixed fee in stage 1, given that they don't expect to earn positive profits in stage 2. There is also no competitive equilibrium with $T^C < 0$. To see why, notice that the supplier can profitably deviate from such an equilibrium by accepting only one of the contracts, say, the contract of R_i. R_i expects that in equilibrium both of the retailers' offers are accepted by the supplier. R_i cannot observe the supplier's deviation of not accepting R_j's contract. Accordingly, in stage 2 R_i sets the equilibrium price p^C. The supplier's profit is $w^C Q(w^C) + T^C$ -- higher than the profit from accepting both offers, $w^C Q(w^C) + 2T^C$ whenever $T^C < 0$. Therefore, in all competitive equilibria, $T^C = 0$.

Next, consider the equilibrium wholesale price in the competitive static equilibrium benchmark, w^C. The equilibrium value of w^C depends on the beliefs regarding out-of-equilibrium strategies. R_i's motivation to deviate depends on its beliefs regarding the supplier's response to this deviation. When R_i makes a deviating offer that the supplier accepts, R_i cannot observe whether the supplier accepted R_j's offer or whether R_j's offer deviated from the equilibrium contract. Suppose that the three firms share the following belief: When R_i's offer to the supplier deviates from the equilibrium contract, making it worthwhile for the supplier to reject R_j's offer, the supplier indeed rejects R_j's offer. These beliefs are close in nature to the "*wary beliefs*" discussed in McAfee and Schwartz (1994) and in what follows we adopt the same terminology.[9] At first blush, it might be thought that the optimal deviation for R_i and the supplier is to a contract with $w_i = 0$, that the supplier accepts, while rejecting R_j's offer. With such a deviation, R_i can set the monopoly price p^*, maximize the joint profits of the supplier and himself, and share these profits with the supplier via T_i. Given that R_i offered to pay the supplier $w_i = 0$, however, the supplier has the incentive to behave opportunistically and accept R_j's offer to pay a positive wholesale price. Under "*wary beliefs*", R_i expects such opportunistic behavior, and hence will not offer to pay the supplier $w_i = 0$.

The following lemma characterizes the set of competitive static equilibria under *wary beliefs*. It shows that in the competitive benchmark case, retailers make zero profits, while the supplier makes a positive profit:

Lemma 1: *Suppose that* $\delta = 0$*. Then, under wary beliefs, there are multiple equilibria with the contracts* $(T^C, w^C) = (0, w^C)$, $w^C \in [w_L, p^*]$, *where* w_L *is the lowest solution to*

$$\max_{w_i}\{w_i Q(p(w_i))\} < w^C Q(w^C) \quad where \quad p(w_i) \in \arg\max_{p}\{(p - w_i)Q(p)\}, \tag{1}$$

and $0 < w_L \le p^*$*. In equilibrium, retailers set* p^C *and earn 0 and the supplier earns* $\pi^C \equiv w^C Q(w^C)$, $\pi^C \in [w_L Q(p(w_L)), p^*Q^*]$.

Proof: see the Appendix.

The result according to which retailers cannot earn positive profits in the competitive equilibrium suggests that in a dynamic, infinitely repeated game, retailers may have an incentive to engage in tacit collusion. When the competitive equilibrium involves $\pi^C < p^*Q^*$, the supplier may have an incentive to collaborate with the two retailers in the tacit collusion equilibrium. In what follows, suppose that the three firms expect that the competitive equilibrium involves $\pi^C < p^*Q^*$ such that all three firms can improve their position by collaborating in a collusive equilibrium. As we will show, our results do not qualitatively depend on the value of π^C as long as $\pi^C < p^*Q^*$.[10]

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[9] In McAfee and Schwartz (1994), under "wary beliefs" a retailer believes that if the supplier offered him a contract that deviates from the equilibrium contract, the supplier offers the competing retailer a contract that maximizes the joint profit of the supplier and competing retailer.

[10] It is possible to show that if retailers have "passive beliefs" according to the definition in McAfee and Schwartz (1994), then any $w^C \in [0, p^*]$ and therefore any $\pi^C \in [0, p^*Q^*]$ can be an equilibrium.

4. Collusive equilibrium with infinitely repeated interaction

4.1. The condition for sustainability of the collusive equilibrium

In this section we solve for the collusive equilibrium in an infinitely repeated game when $1 \geq \delta > 0$. In this equilibrium, in the first stage both retailers offer the same equilibrium contract, (w^*,T^*) that the supplier accepts. Then, in stage 2, both retailers set the monopoly price, p^*, and equally split the monopoly quantity, Q^*. Given an equilibrium w^*, each retailer earns in every period $\pi_R(w^*) = (p^* - w^*)Q^*/2 - T^*$ and the supplier earns in every period $\pi_S(w^*) = w^*Q^* + 2T^*$.

In order to support the collusive scheme, the contract (w^*,T^*) must prevent deviations from this scheme. R_i can observe whether R_j deviated from the collusive price p^*, thereby dominating the downstream market. R_i cannot observe, however, whether this deviation is a result of R_j offering the supplier a different contract than (w^*,T^*), which motivates R_i to deviate from the monopoly price, or whether R_j offered the supplier the equilibrium contract (w^*,T^*), but nevertheless undercut the monopoly price. It is only the supplier and R_j that will know which type of deviation occurred. R_i can also observe whether R_j did not carry the product in a certain period. R_i cannot tell, however, whether this is a result of a deviation by R_j (i.e., R_j offered a different contract than (w^*,T^*) that the supplier rejected) or by the supplier (i.e., R_j offered the equilibrium contract (w^*,T^*), but the supplier rejected). Finally, another type of deviation is when R_i offers a contract different than (w^*,T^*) that the supplier accepted, but then R_i continued to set p^*. R_j will never learn of this deviation, since contracts are secret. Because of the dynamic nature of the game and the asymmetry in information, there are multiple collusive equilibria. We therefore make the following restrictions. First, suppose that whenever a publicly observable deviation occurs (i.e., a retailer sets a different price than p^* or does not carry the product), retailers play the competitive equilibrium defined in section 3 in all future periods.[11] Second, since we concentrate here on retailers with strong bargaining power, we focus on outcomes that provide retailers with the highest share of the monopoly profit that ensures the supplier at least its competitive equilibrium profit, π^C.[12]

To solve for the collusive equilibrium, we first consider necessary conditions on (w^*,T^*). Then, we show that these conditions are also sufficient. The first condition is that once retailers offered a contract (w^*, T^*) that the supplier accepted, R_i indeed plays in stage 2 the monopoly price p^* rather than deviating to a slightly lower price. By deviating R_i gains all the

[11] We consider an alternative trigger strategy in section 4.5.

[12] Retailers may also be able to coordinate on the competitive equilibrium outcome and choose the lowest π^C possible, $w_LQ(w_L)$. Our qualitative results do not rely on the size of π^C, however, as long as collusion is weakly beneficial to all three firms (i.e., $\pi^C < p^*Q^*$). Accordingly, we solve for the collusive equilibrium for any arbitrary π^C.

demand in the current period, but stops future collusion. R_i will not deviate from collusion in the second stage if:

$$(p^*-w^*)\tfrac{1}{2}Q^*+\frac{\delta}{1-\delta}\left((p^*-w^*)\tfrac{1}{2}Q^*-T^*\right)\geq(p^*-w^*)Q^*\ , \tag{2}$$

where the left hand side is R_i's profit from maintaining collusion and the right hand side is R_i's profit from deviating. Notice that condition (2) is affected only by the retailers' discount factor and not by the supplier's, because this constraint involves a deviation by a retailer assuming the supplier had not deviated: he played the equilibrium strategy and accepted the two equilibrium contract offers in stage 1.

The second necessary condition is the supplier's participation constraint:

$$\frac{w^*Q^*+2T^*}{1-\delta}=w^*Q^*+T^*+\frac{\delta}{1-\delta}\pi^C. \tag{3}$$

The left hand side is the supplier's profit from accepting the two equilibrium contracts and thereby maintaining collusion. The right hand side is the supplier's profit from accepting only one of the contracts. If the supplier rejects R_i's offer, R_j can detect this deviation only at the end of stage 2, when R_j observes that R_i doesn't offer the product. Therefore, in stage 2 R_j will still charge the monopoly price p^* and sell Q^*, implying that the supplier earns in the current period $w^*Q^* + T^*$ and collusion breaks down in all future periods, in which the supplier earns π^C. If the left hand side of (3) is higher than the right hand side, then R_i has the incentive to deviate to a contract with a lower T_i, that the supplier would accept, since even with this lower T_i, the supplier prefers collusion to deviation. If the right hand side of (3) is higher than the left hand side, then when both retailers offer the equilibrium contract, the supplier will deviate from the equilibrium strategy in stage 2 and accept only one of the contracts. Therefore, condition (3) must hold in equality. Notice that this condition is affected by the supplier's discount factor only, and not by the retailers' discount factor, because it deals with the supplier's deviation given that retailers had offered the equilibrium contracts.

Extracting T^* from (3) and substituting into $\pi_R(w^*)$, we can rewrite the supplier and retailers' one-period profits as a function of w^* as:

$$\pi_R(w^*)=\left(p^*-\frac{1-\delta}{1+\delta}w^*\right)Q^*/2-\frac{\delta}{1+\delta}\pi^C,\quad \pi_S(w^*)=\frac{1-\delta}{1+\delta}w^*Q^*+\frac{2\delta}{1+\delta}\pi^C. \tag{4}$$

As can be expected, $\pi_R(w^*)$ is decreasing in w^* while $\pi_S(w^*)$ is increasing in w^*.

The two conditions above ensure that the supplier accepts the two equilibrium contracts and that each retailer sets p^* if the supplier accepts its equilibrium contract. The remaining requirement is that R_i does not find it profitable to deviate in stage 1 to any other contract (w_i, T_i) ≠ (w*, T*). The benefits of R_i and the supplier from such a deviation depend on their out-of-equilibrium beliefs concerning each other's future strategies given the deviation. That is, whether the supplier will accept the contract offers of both retailers or just one of them and whether R_i will continue colluding or not. We apply wary beliefs as follows. Suppose that given any deviation to (w_i, T_i) ≠ (w*, T*), the supplier and R_i share common beliefs on how each of them will respond to this deviation. That is, we assume that in deciding whether to accept a deviating contract or not, the supplier correctly anticipates whether the deviating contract will motivate R_i to undercut the collusive price, should the supplier indeed choose to accept it. Likewise, if the supplier indeed accepts the deviating contract, R_i correctly anticipates whether the supplier finds it optimal to accept the contract of R_j as well. Notice that this assumption rules out a "naive" supplier, that will wrongly anticipate that a certain contract deviation motivates R_i to set the collusive price, while in practice R_i will undercut it.[13] Given these common beliefs, the supplier accepts the contract offers of both retailers only if it is profitable for the supplier to do so.

Proposition 1 shows that given conditions (2), (3) and $\pi_S(w^*) \geq \pi^C$ and given wary beliefs, R_i cannot profitably deviate to any (w_i, T_i) ≠ (w*, T*). Therefore, conditions (2), (3) and $\pi_S(w^*) \geq \pi^C$ are also sufficient for sustainability of the collusive equilibrium. Proposition 1 also characterizes the unique collusive contract that maximizes the retailers' profits subject to (2), (3) and $\pi_S(w^*) \geq \pi^C$.

Proposition 1: *Suppose that* $\delta > 0$. *Then, under wary beliefs, there is a unique collusive equilibrium that maximizes the retailers' profits subject to* (2), (3) *and* $\pi_S(w^*) > \pi^C$. *In this equilibrium:*

$$w^* = \begin{cases} p^* - \dfrac{2\delta^2(p^*Q^* - \pi^C)}{(1-\delta)Q^*}; & \delta \in (0, \tfrac{1}{2}]; \\ \dfrac{\pi^C}{Q^*}; & \delta \in [\tfrac{1}{2}, 1]; \end{cases} \tag{5}$$

$$and: \qquad T^* = \begin{cases} -\dfrac{\delta}{1-\delta}(1-2\delta)(p^*Q^* - \pi^C); & \delta \in (0, \tfrac{1}{2}]; \\ 0; & \delta \in [\tfrac{1}{2}, 1]. \end{cases} \tag{6}$$

Proof: see the Appendix.

Substituting (5) into (4) yields that the retailers and the supplier earn in equilibrium $\pi_R^* \equiv \pi_R(w^*)$ and $\pi_S^* \equiv \pi_S(w^*)$ where:

[13] It is possible to show that when the supplier is "naive" by wrongly anticipating that a certain contract deviation will not motivate R_i to undercut the collusive price, all collusive equilibria fail for δ < 1/2.

$$\pi_R{}^* = \begin{cases} \delta(p^*Q^* - \pi^C); & \delta \in (0,\tfrac{1}{2}]; \\ \tfrac{1}{2}(p^*Q^* - \pi^C); & \delta \in [\tfrac{1}{2},1]; \end{cases} \qquad \pi_S{}^* = \begin{cases} (1-2\delta)p^*Q^* + 2\delta\pi^C; & \delta \in (0,\tfrac{1}{2}]; \\ \pi^C; & \delta \in [\tfrac{1}{2},1]. \end{cases} \tag{7}$$

4.2. The features of the retailers' most profitable collusive equilibrium

Let $SA^* = -T^*$ denote the equilibrium slotting allowance. The following corollary describes the features of the retailers' most profitable collusive equilibrium, while figure 1 illustrates the retailers' most profitable collusive equilibrium as a function of δ.

Corollary 1: *In the retailers' most profitable collusive equilibrium:*

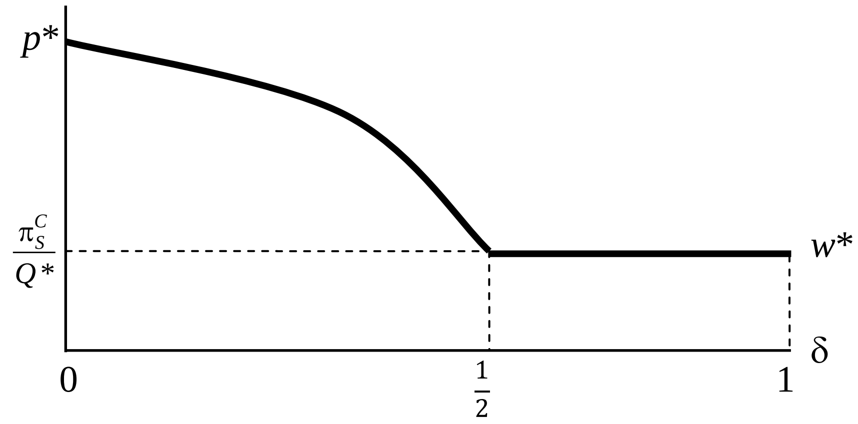
(i) *For* $\delta \in (0, 1/2]$:

- *retailers' one-period profits are increasing with* δ *while the supplier's one-period profit is decreasing with* δ;
- *the equilibrium wholesale price is decreasing with* δ*;*
- *The supplier pays retailers slotting allowances:* $SA^* > 0$*. The slotting allowances are an inverse U-shape function of* δ.

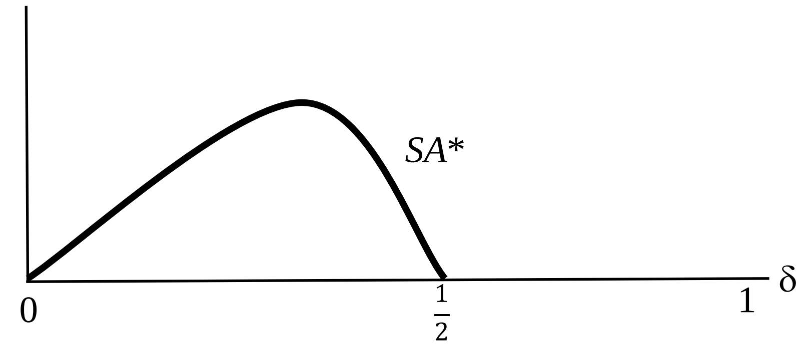
(ii) *For* $\delta \in [1/2, 1]$:

- *the equilibrium wholesale price and the firms' profits are independent of* δ *and retailers do not charge slotting allowances*: $T^* = 0$;
- *the supplier earns its reservation profit* (*from the competitive equilibrium*) *and retailers earn the remaining monopoly profits*.

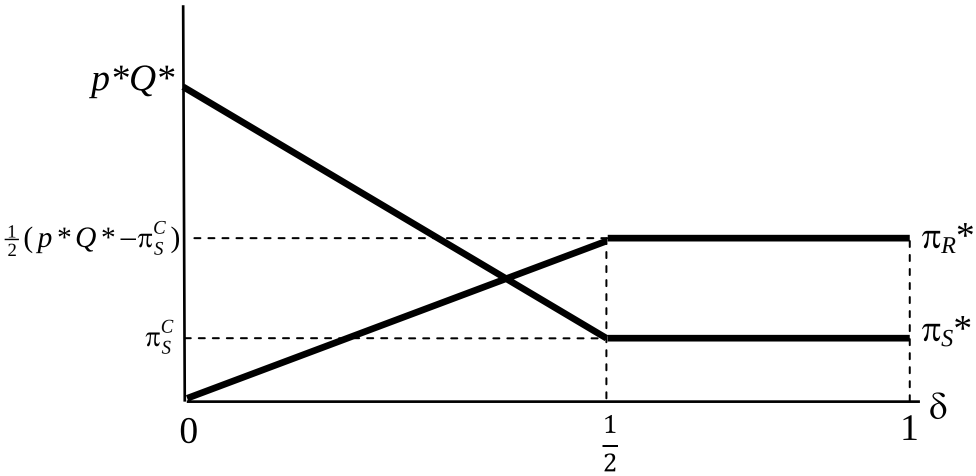
Figure 1 and part (i) of Corollary 1 reveal that at $\delta \to 0$, $w^* \to p^*$, $SA^* \to 0$ and the supplier earns most of the monopoly profits. As δ increases, w^* decreases and retailers gain a higher proportion of the monopoly profits. Moreover, the equilibrium slotting allowances are an inverse U-shaped function of δ. The intuition for these results is as follows. Consider first the case where $\delta = 0$. Since retailers do not care about the future, the only possible w^* that motivates a retailer to set the monopoly price in stage 2 is $w^* = p^*$. For any other $w^* < p^*$, an individual retailer will deviate in stage 2 to a price slightly below p^* and monopolize the market, ignoring the negative effect of doing so on future profits. Since the supplier also does not care about the future, and since $w^* = p^*$, retailers cannot charge slotting allowances. To see why, notice that if R_i asks for a slotting allowance, the supplier can reject R_i's contract and earn $\pi_S(w^*) = w^*Q^* = p^*Q^*$ from accepting the contract of R_j and ignoring the negative effect of breaking collusion in the future. As a result, with $w^* = p^*$ and without slotting allowances, a collusive equilibrium requires the supplier to gain all of the monopoly profits. However, in such a case retailers have week incentives to participate in the collusive equilibrium to begin with.



Panel (a): The equilibrium *w as a function of δ**



Panel (b): The equilibrium *SA as a function of δ**



Panel (c): The firms' equilibrium profits as a function of δ

Figure 1: The features of the retailers' most profitable equilibrium as a function of δ

Suppose now that δ increases slightly above 0. In this case retailers have two complementary ways to collect a positive share of the monopoly profit from the supplier. First, now R_i can charge slotting allowances. If the supplier rejects R_i's contract and accepts only R_j's contract, the supplier earns a one-period profit close to the monopoly profit in the current period, but collusion breaks in future periods. Since now the supplier cares about the future, R_i can ask for slotting allowances, which the supplier accepts, just in order to maintain collusion in the following periods.

The second option that R_i can use in order to gain a positive share of the monopoly profit is by reducing w^* below p^*. Now that retailers care about the future, they can sustain collusion even for a smaller w^*. Intuitively, the higher is w^*, the lower is R_i's profit margin, and the lower is its short-term profit from deviating from p^* in stage 2. To see why, notice that whenever R_i sets p^*, R_i earns in the current period a profit margin of $p^* - w^*$ on *half* of the monopoly quantity, while by deviating to a slightly lower price than p^*, R_i can earn a profit margin $p^* - w^*$ on *all* the monopoly quantity. Accordingly, when $\delta = 0$ the only possible collusion-supporting wholesale price is $w^* = p^*$. However, when δ is slightly higher than 0, R_i cares about the future, and in stage 2 will charge the monopoly price even when $w^* < p^*$. Hence, when $\delta > 0$, R_i can exploit the supplier's concern about future profits (through condition (3)) in order to charge slotting allowances and can exploit its own concern about future profits (through condition (2)) in order to reduce w^*. Therefore, in equilibrium, retailers ask for slotting allowances and set $w^* < p^*$, both enabling them to gain a positive share of the monopoly profit. As δ increases, the supplier's incentive to maintain collusion increases, and retailers can take advantage of it by offering a contract that allocates to them a higher share of the monopoly profit. As a result, the retailers' profits increase with δ while the supplier's profit decreases with δ. This also explains why the equilibrium w^* decreases with δ. As δ increases, retailers have more of an incentive to maintain the collusive equilibrium, and therefore a lower w^* is sufficient for motivating retailers not to undercut the monopoly price in stage 2.

The effect of δ on the level of slotting allowances is non-monotonic, because δ has two opposite effects on the level of slotting allowances. First, there is a positive direct effect, because the more the supplier cares about the future, the higher the slotting allowances the supplier is willing to pay to maintain collusion. Second, an indirect negative effect, because as δ increases, w^* decreases. This in turn reduces the supplier's willingness to pay slotting allowances. The first effect dominates for low values of δ while the second effect dominates for high values of δ.

Part (ii) of Corollary 1 reveals that when $\delta > 1/2$, retailers sufficiently care about the future to maintain collusion without the aid of the supplier. Accordingly, retailers keep the supplier on its profit when collusion breaks down, π^C, and earn the remaining monopoly profits. As a result, the firms' profits and the equilibrium contract are not a function of δ. The intuition follows from the benchmark case in section 2, where two firms that compete in prices can maintain collusion on their own for $\delta > 1/2$.

Corollary 1 shows that as δ increases, retailers gain a higher share of collusive profits and the supplier's share diminishes while when δ is small, retailers have a smaller share of the collusive profits, and most of the monopoly profits go to the supplier. This implies that even though retailers have all of the bargaining power and are asking (and receiving) slotting allowances, they are not always the main beneficiaries of the collusive scheme.

Finally, we are interested in asking whether retailers can maintain a collusive equilibrium when they cannot charge $T^*<0$. Notice that the answer to this question does not directly follow from proposition 1, because this proposition only shows that the retailers' most profitable collusive equilibrium involves slotting allowances. It is yet to be determined whether a collusive equilibrium is still possible when retailers cannot charge negative fees. In the context of this model, the following corollary shows that for $\delta\in(0, 1/2]$, firms cannot maintain *any* collusive equilibrium without using slotting allowances.

Corollary 2: *If* $\delta < 1/2$, *then there are no contracts* (w^*, T^*) *that can maintain a collusive equilibrium with* $T^* \geq 0$.

Proof: see the Appendix.

The intuition for corollary 2 is that a high wholesale price has two conflicting effects on the retailers' incentive to collude. First, a positive short-run effect, in that a high wholesale price decreases the profit a retailer can earn in the current period by undercutting the collusive price. Second, a long-run negative effect, because a high wholesale price (also to be paid in future periods) decreases the retailer's future profits from maintaining collusion. In order to offset the second, negative effect, future contracts need to involve fees paid by the supplier to the retailer. Notice that in the current period, the retailer earns the slotting allowance regardless of whether the retailer charges the collusive price or not. These fees are set in the first stage of the current period and will have already been paid in the second stage of the current period, when the retailer sets its price. Nevertheless, the retailer knows that if it does not charge the collusive price in the current period, he will not receive slotting allowances in future periods. This is what induces the retailer to maintain collusion in the current period.

4.3 Competition among suppliers

Until now, we have assumed that the supplier is a monopoly. Because the monopolistic supplier cares about future profits, he assists downstream collusion even for $\delta < 1/2$. An important question is whether competition among suppliers causes the collusive scheme to break down. The main conclusion of this section is that retailers cannot maintain the collusive equilibrium when they have the option to buy the input from a competitive supplier.

Suppose now that the market includes a dominant supplier, S_1, and a competitive supply market, which consists of one or more identical suppliers, $S_2 \ldots S_n$.. The dominant supplier discounts future profits by δ while the competitive suppliers are myopic. We ask whether the two retailers can sustain a collusive equilibrium in which they offer only the dominant supplier a contract (w^*,T^*) that the dominant supplier accepts, and then charge consumers p^*. As before, we assume that any observable deviation in period t triggers the competitive equilibrium from period $t + 1$ onwards. We further assume that in this competitive equilibrium, all firms earn zero. That is, $\pi^C = 0$.

In order to maintain a collusive equilibrium, the collusive contract has to satisfy conditions (2) and (3). In addition, the collusive contract needs to eliminate the incentive of R_i to deviate from collusion by offering the collusive contract to the dominant supplier and at the same time making a secret contract offer to a competing supplier with $w_i = T_i = 0$ (we are assuming, for now, that R_i may not offer the dominant supplier to buy exclusively from it, and later relax this assumption). To see the profitability of such a unilateral deviation, suppose that R_j plays according to the proposed equilibrium by offering (w^*,T^*) to the dominant supplier only, but the deviating retailer, R_i, offers (w^*,T^*) to the dominant supplier and at the same time makes a secret offer to S_2 with $w_i = T_i = 0$. The dominant supplier will accept both offers, because it is unaware of R_i's secret offer to S_2. Hence R_i will earn a slotting allowance, $-T^* > 0$, from the dominant supplier.

Moreover, R_i can then charge consumers a price slightly below p^*, dominate the market and earn $p^*Q^* - T^*$. If this deviation is profitable for R_i even though it breaks down collusion in all future periods, the collusive equilibrium fails. Therefore, the equilibrium requires that R_i's discounted future profits from the collusive equilibrium are higher than a one-period deviation in which R_i buys from the competitive supplier. That is:

$$\frac{(p^* - w)Q^*/2 - T^*}{1-\delta} \geq p^*Q^* - T^*.$$

To see whether this condition holds, recall from equation (7) that the highest sum of discounted profits that a retailer can earn in a collusive equilibrium – the retailers' most profitable collusive equilibrium – is $\delta p^*Q^*/(1 - \delta)$ (note that when collusion breaks down π^C

= 0). According to corollary 2, in any collusive equilibrium $T^* < 0$, and hence the lowest profit that a retailer can make by making a secret offer to a competitive supplier, is p^*Q^*. However:

$$p^*Q^* \geq \frac{\delta p^*Q^*}{1-\delta} \quad \Leftrightarrow \quad \delta \leq \tfrac{1}{2}, \tag{8}$$

implying that R_i will deviate from this collusive equilibrium by making the secret offer to the competing supplier. The following corollary summarizes this result:

Corollary 3: *Suppose that the upstream market includes a dominant supplier and a competitive supply market. Then, if δ < ½, there is no collusive equilibrium in which the two retailers collude by signing in every period a contract with a dominant supplier.*

Intuitively, for δ < ½, retailers are too short-sighted and have a strong incentive to deviate from collusion. A dominant supplier is therefore needed in order to assist them in colluding, since otherwise collusion breaks down. But when retailers can buy the product at $w = 0$ from a competitive supplier, the dominant supplier's ability to assist retailers in reaching a collusive equilibrium is eliminated.

The result of corollary 3 continues to hold even when the competing suppliers are not myopic but rather forward looking, i.e., they have a discount factor δ > 0. In an equilibrium in which the two retailers deal with the dominant supplier only, all other suppliers earn 0 and they do not have any outside option. Suppose R_j plays according to the proposed equilibrium by offering (w^*,T^*) to the dominant supplier only, but the deviating retailer, R_i, offers (w^*,T^*) to the dominant supplier and at the same time makes a secret offer to S_2 with $w_i = T_i = 0$. Even a forward looking S_2 would accept such a deviating offer, because S_2 earns 0 anyway if it rejects R_i's offer. As before, R_i could then earn $p^*Q^* - T^*$ from deviating, which is higher than R_i's expected profit from the collusive equilibrium if δ < 1/2.

One might expect that retailers would want to mimic the monopoly upstream market result and restore their ability to collude by signing exclusive dealing agreements with one supplier and granting him monopoly power. Such a strategy, however, is similarly vulnerable to retailers' incentive to deviate. Suppose now that a retailer can offer a supplier an exclusive dealing contract in which the retailer commits not to buy during the relevant period from any competing supplier. The results of Corollary 3 still hold and collusion breaks down in the presence of competing suppliers. To see why, suppose that retailers can commit to an exclusive dealing contract, which is valid for one period at a time. Consider a collusive equilibrium in which in every period, each retailer offers the dominant supplier the collusive contract along with an exclusive dealing clause. The exclusive dealing obligation excludes the possibility that a retailer make an offer to the dominant supplier while ending up buying the product from a competing supplier. Nevertheless, a retailer can choose not to make an offer to the dominant supplier at all, and instead make an offer only to a competing supplier, with $w = T = 0$. The retailer's profit from deviation would no longer be $p^*Q^* - T^*$ but only p^*Q^*. However, it follows from (8) that the result of corollary 3 remains intact: collusion is still impossible for $\delta < 1/2$.

Hence, collusion and exclusive dealing are not practices that can sustain each other: when collusion is vulnerable to deviation by a retailer, so is exclusive dealing with a mutual supplier.[14] There must be an external commitment mechanism that ties both retailers to the same supplier. This external commitment mechanism can take the form of a long-term contract both retailers sign with the same supplier. For example, suppliers of dominant brands are often made “category captain” of the relevant category within the branches of all leading retail chains and can use this position to eliminate rivals who may cut wholesale prices.[15] Alternatively, one of the suppliers may have some inherent advantage. For example, he may offer a brand or product that is a “must have” brand for retailers. When retailers must purchase a portion of their requirements from a particular supplier, the supplier can relatively cheaply use loyalty rebates to induce retailers to operate exclusively with him.[16] Another external commitment device that can secure exclusivity, despite retailers’ inherent incentive to breach it, may be a relationship-specific investment made by the retailer that ties the retailer to a particular supplier (such as specific computer software, training of employees that is particular to the supplier, and so forth).

4.4 The Implications for antitrust policy

Our results have several antitrust implications. The first is with regard to the use of slotting allowances – the fees that retailers, especially supermarkets and drugstores, ask from suppliers, usually as compensation for the retailer’s shelf space.

Note that "slotting allowances," in our context, include any fixed payment the supplier pays a retailer, regardless of its purpose. It need not be in exchange for shelf space, as traditionally predicted. Indeed, in practice, fees suppliers pay retailers, not in the form of per unit discounts, are paid for an array of “excuses” or “reasons”.[17] Under US case law, to

[14] We discuss the robustness of our results to the possibility of sequential offers in the conclusion.
[15] See, e.g., the cases of *Conwood,* and *Church & Dwight Co., Inc.*, supra note 4.
[16] See Nalebuff (2005).
[17] As the industry literature shows, there are various "excuses" for such payments, including fees in consideration for promotion or advertising, or introductory allowances (see, e.g., FTC (2003)), listing fees, contributions for new store openings or store refurbishments, end of period bonuses, mergers and acquisitions, reimbursement of expenditures, and so forth. An EC study examining slotting allowances in the different European member states reports that over 500 different types of payments paid by suppliers to retailers were used (See Stichele and Young (2008)).

date, slotting allowances have been rarely condemned, under the rule of reason, and only to the extent that they are paid in exchange for dominating retailers' shelf space in a way that is likely to exclude rival suppliers.[18] In our context, by contrast, the harm to competition stems from the mere payment of fixed fees by a dominant supplier to retailers. As long as the dominant supplier maintains its dominance in some way, the fees themselves need not have any exclusionary effect on rival suppliers for them to harm competition. It is not their exclusionary nature which harms competition in our model, but rather the fact that they serve as a "prize" the supplier is willing to pay retailers in exchange for retailers' adherence to the collusive scheme.[19]

Interestingly, the European Commission's guidelines on vertical restraints briefly identify that slotting allowances may facilitate downstream collusion.[20] The guidelines do not deal, however, with the fact that under the economic literature to date, one retailer needs to observe its rival's contract with the supplier in order for slotting allowances to facilitate downstream collusion. The main contribution of Corollary 2 is in showing that slotting allowances can be anti-competitive even in the common case when contracts between suppliers and retailers are secret. Usually, a retailer cannot observe its rivals' contracts with the supplier. After all, exchange of information among retailers competing in a relevant market regarding their commercial terms with a common supplier would most probably be condemned as an antitrust violation.[21] We show that even though each retailer cannot observe the contract between the supplier and the competing retailer, retailers know that the supplier observes both contracts and has an incentive to maintain collusion. Therefore, a retailer cannot profitably convince the supplier to accept a contract that motivates the retailer (and the supplier) to deviate from the collusive equilibrium.

Corollary 1 and proposition 1 also indicate that the anti-competitive effect of slotting allowances is not necessarily related to their size. When δ is close to zero, even though firms are very shortsighted such that it should be very difficult for them to maintain collusion, still a small slotting allowance is enough to maintain the collusive equilibrium. As firms care more

[18] See, e.g., *Conwood*, supra note 4; Church & Dwight Co. INC. v. Mayer Laboratories, INC. 868 F.Supp.2d 876, (N.D. California 2012).

[19] As we show in section 4.3 above, competition among suppliers may dissipate the anticompetitive effect of slotting allowances. Hence, in the case of slotting allowances that are used to induce all retailers to buy exclusively from one supplier, their anticompetitive effect is exacerbated.

[20] See European Commission (2012). In the EU, slotting allowances, like most vertical restraints, enjoy a safe harbor if both the supplier's and each retailer's market share is below 30%. See European Commission (2010). Some of the member states at the EU included strict prohibitions of slotting allowances, such as France (see Article L-442-6 of the French Code de Commerce); the UK (see GSCOP, Part 5, 12) and a proposed prohibition in Ireland (see Lianos 2010). A similar prohibition exists in Israel (The Law for the Promotion of Competition in the Food Sector, 2014), and Poland banned the practice in 1993 (see The Economist, 2015). In addition, Chinese authorities have challenged retailers for charging excessive slotting allowances in 2011 (The Economist, 2015).

[21] See sources cited supra note 7.

about future profits, even though it becomes easier for them to collude, the size of slotting allowances actually increases. Then, after a certain threshold of δ, the easier it becomes to sustain collusion (as δ increases), the size of the slotting allowances decreases again. This result indicates that antitrust authorities cannot necessarily infer the potential anti-competitive effect of slotting allowances from their mere magnitude.

In some cases, slotting allowances are paid by suppliers as compensation for intense competition among retailers over selling the supplier's brand.[22] Our results imply that such scenarios may deserve more lenient antitrust treatment, provided that the claim of compensation for intense competition is not a sham. In our framework, during or after a price war between retailers, when collusion collapses, slotting allowances are no longer used (see Lemma 1). On the contrary, when collusion collapses, the supplier stops paying retailers slotting allowances in our framework, in order to punish retailers for not adhering to the collusive scheme. Conversely, if slotting allowances are paid under different circumstances, they should raise particular suspicion. Our results imply that, at least in the case where retailers purchase from only one supplier in a relevant supply market, and absent compelling pro-competitive motivations for using slotting allowances, they should be treated with high scrutiny: not only do they raise the probability of sustaining collusion, but their existence implies that they actually enabled collusion. Recall from Lemma 1 that the competitive equilibrium benchmark cannot involve slotting allowances, and from Corollary 1 that for $\delta > 1/2$ (where collusion is sustainable even without the supplier's help) there are no slotting allowances. Hence, had collusion not been sustainable, or alternatively, had collusion been sustainable even without the help of slotting allowances, the model predicts that there would not have been any slotting allowances in equilibrium.

Note that for slotting allowances to facilitate downstream collusion, they must take the form of fixed payments, rather than mere per-unit discounts. A per unit discount granted by the supplier to a retailer would ruin the collusion-facilitating nature of the scheme, since it is the elevated wholesale price per-unit that deters retailers from deviating from collusion.

All of the policy implications above concern a monopolistic supplier. Our results in section 4.3 and corollary 3, however, imply that when the supplier faces aggressive competition from suppliers, slotting allowances can no longer facilitate downstream collusion. This justifies more lenient antitrust treatment of slotting allowances in such cases.

Accordingly, the anticompetitive effect of slotting allowances in facilitating collusion among retailers, according to our results, stems from concentration in the *supplier's* market, rather than in the *retailers'* market. It is straightforward to extend the model to any finite number of retailers and obtain a collusive equilibrium, as long as there is a monopoly

[22] See, e.g., Moulds (2015).

supplier. Hence an even extremely competitive structure of the retail market cannot serve as a defense for slotting allowances paid by a dominant supplier.

As shown, even a period by period attempt by retailers to promise the dominant supplier to buy exclusively from it collapses for low discount factors. Only an extreme form of exclusive dealing, where all retailers make a long term commitment, through some external mechanism, to buying from the same supplier, coupled by slotting allowances, can facilitate downstream collusion.

Our results also have more general policy implications with regard to vertical restraints that help enforce the elimination of downstream competition, such as minimum resale price maintenance, suggested retail prices, or exclusive territories. According to the "Chicago School" approach, such vertical restraints should be treated leniently by antitrust authorities, since, given the wholesale price the supplier charges, and given that the supplier earns no fixed fees from the retailers (but, on the contrary, pays the retailers slotting allowances) we would expect him to prefer intense retail competition. According to this reasoning, elimination of downstream competition only harms the supplier, since it reduces the number of units sold, and the supplier's only profits stem from the per-unit wholesale price. If the supplier does try to eliminate downstream competition, so the argument goes, it must be due to efficiencies in distribution rather than to harm consumers. According to this approach, a resale price dictated or suggested by the supplier would typically be considerably lower than the monopoly retail price.[23] As we show, however, the supplier may strategically wish to sustain collusion among retailers over the monopoly retail price. This is because the supplier too reaps some of the profits from sustaining the monopoly price, and manages to charge a higher wholesale price than he would have been able to charge absent the collusive scheme. In our model, such collusion is achieved tacitly, and the supplier assists it via the wholesale price he charges and the slotting allowances he pays. But in the real world, the supplier may well attempt to make sure downstream collusion is sustainable by using more intrusive vertical restraints, such as minimum resale price maintenance, exclusive territories, or suggested resale prices. In such occasions, our results imply that the above-mentioned lenient approach may not be justified, and that the retail price dictated or suggested by the supplier may well be the monopoly retail price.

[23] Marvel (1994), for example, argues that "manufacturers will not voluntarily enforce cartels for their dealers … a manufacturer has no more interest in inefficient distribution than do consumers ... . Higher mark ups [for retailers] mean that the net-of-margin demand curve faced by the manufacturer is lower than need be. Lower demand curves are less profitable. If retailer price competition is suppressed, the manufacturer must anticipate some benefit to offset the adverse effects of the higher dealer margins that result." For similar arguments in the legal and economic literature see, e.g., Bork (1978); Posner (1976); (1981); Easterbrook (1984); Telser (1960); Katz (1989); and Taussig (1916).

4.5 Alternative trigger strategy

The previous section shows that for $\delta < 1/2$ the supplier earns higher profits than π^C even though retailers have the bargaining power to make take-it-or-leave-it offers and can coordinate on their most profitable collusive equilibrium. This result is driven by the assumption that if R_i observes that R_j didn't carry the product, R_i interprets it as a deviation by R_j and stops collusion. Such a trigger strategy provides the supplier with bargaining power, because if the supplier rejects R_j*'s* equilibrium offer, R_j will not carry the product, and consequently R_i will stop collusion. In this subsection we ask whether retailers can earn higher profits by using a softer trigger strategy, which removes the bite from the supplier's ability to stop downstream collusion by rejecting a retailer's offer.

Suppose that whenever R_i observes that R_j didn't carry the product, R_i interprets it as a deviation by the supplier rather than by R_j and continues with the collusive equilibrium. R_i stops offering the collusive contract only if R_j carried the product in the previous period but charged a different price than p^*. Under such a trigger strategy, the supplier's decision whether to accept a retailer's offer no longer affects future collusion. Supposedly, retailers' benefit from this alternative trigger strategy is that it may help them obtain a higher share of the monopoly profits. The disadvantage of this strategy for retailers, however is that it increases their profit from defecting from the collusive equilibrium at the first stage of every period, as now the supplier cannot punish a retailer who did so.

With this alternative trigger strategy, condition (2) is still necessary to support a collusive equilibrium, because this condition prevents R_i from defecting from collusion in the second stage of the period. Turning to the supplier's participation constraint, given that both retailers offer the equilibrium collusive contracts, the supplier's decision on whether to accept both of them or just one is not going to affect the future. Hence the supplier's participation constraint could be written as:

$$Q^*w^* + 2T^* = Q^*w^* + T^*, \tag{9}$$

where the left-hand-side is the supplier's profit from accepting the two equilibrium contracts and the right-hand-side is the supplier's profit from accepting only one of them. Neither of the supplier's decisions affects collusion, and hence the supplier does not sacrifice any of his own future collusive profits by rejecting an equilibrium contract. This condition requires that $T^* = 0$. However, the proof of Corollary 2 showed that (2) cannot hold if $T^* \geq 0$ and $\delta < ½$, implying that this alternative trigger strategy cannot maintain a collusive equilibrium.

Corollary 4: *Suppose that* $\delta < 1/2$ *and retailers do not stop collusion if they observe that the supplier accepted only one of the contract offers. Then, there are no contracts* (w^*, T^*) *that can maintain a collusive equilibrium.*

Corollary 4 shows that the retailers need the supplier to police their collusion and they need to share future collusive profits with the supplier for collusion to be sustainable at low values of δ. If the supplier's role as enforcer of collusion is eliminated, there is no vertical contract in which collusion is sustainable. Retailers must charge slotting allowances for them to be willing to collude for low values of δ. But if retailers do not share collusive profits with the supplier, and retailers ask for slotting allowances, the supplier always rejects one of the retailer's offers.

Consider now the case where $\delta > 1/2$. In the collusive equilibrium that we defined in Proposition 1, for such discount factors, the supplier earns only its reservation profit, π^C. Hence retailers cannot do better by adopting an alternative trigger strategy.

5. Differentiated retailers

This section considers horizontally differentiated retailers. The main conclusion of the section is that secret vertical contracts can facilitate collusion even when retailers are differentiated. However, unlike the case of homogeneous retails, differentiated retailers and their joint supplier cannot maintain collusion for all values of δ. As retailers become closer substitutes, vertical contracts that include slotting allowances facilitate collusion for a larger range of discount factors.

In order to investigate how the *degree* of differentiation between the two retailers affect our results, consider a representative consumer with the utility function:

$$U(q_1, q_2) = \sum_{i=1}^{2}\left(q_i - \tfrac{1}{2}q_i^2\right) - \sigma q_1 q_2 - \sum_{i=1}^{2}\left(q_i p_i\right), \tag{10}$$

where q_i and p_i are the price and quantity of R_i, and σ measures the degree of horizontal differentiation between the two retailers. When $\sigma = 0$, the two retailers are monopolies and they become closer substitutes as σ is closer to 1. Differentiating (10) with respect to q_1 and q_2 yields the demand function facing R_i:

$$q_i(p_i, p_j) = \frac{1}{1+\sigma} - \frac{1}{1-\sigma^2}\, p_i + \frac{\sigma}{1-\sigma^2}\, p_j\,.$$

Consider first the benchmark case of collusion between retailers that behave as two competing firms that can obtain the input at marginal costs 0. We ask under which values of δ the two retailers can collude without using vertical contracts. The collusive prices that maximize the monopoly profit, $p_1q_1(q_1,q_2) + p_2q_2(q_2,q_1)$ are $p_1 = p_2 = p^* = 1/2$ which yields the monopoly quantity and profit of:

$$q^* \equiv q_i(p^*, p^*) = \frac{1}{2(1+\sigma)}, \quad \pi^* \equiv p^* q^* = \frac{1}{4(1+\sigma)}.$$

The competitive price of firm i maximizes $p_i q_i(p_i, p_j)$ given p_j. Hence, the competitive price, quantity and profit are

$$p^C = 1 - \frac{1}{2-\sigma}, \quad q^C \equiv q_i(p^C, p^C) = \frac{1}{2+\sigma-\sigma^2}, \quad \pi_R^C \equiv p^C q^C = \frac{1-\sigma}{(2-\sigma^2)(1+\sigma)}.$$

Notice that as $\sigma \to 1$, the two products become close substitutes and therefore $p^C \to 0$ and $\pi_R{}^C \to 0$.

When R_j sets the collusive price, p^*, while R_i deviates from collusion, then R_i sets p_i as to maximize $p_i q_i(p_i, p^*)$. Let $p_i(p_j)$ denote R_i's best-response to p_j. Hence, the deviating price, quantity and profit are:

$$p(p^*) = \tfrac{1}{4}(2-\sigma), \quad q(p(p^*), p^*) = \tfrac{1}{4}\frac{2-\sigma}{(1-\sigma^2)}, \quad \pi^D \equiv p(p^*)\, q(p(p^*), p^*) = \tfrac{1}{16}\left[\frac{2-\sigma}{(1-\sigma^2)}\right]^2.$$

In what follows, we make the simplifying assumption that $0 < \sigma < \sqrt{3} - 1 \cong 0.73$. When σ is close to 1, the two retailers are close substitutes and therefore when a retailer deviates from the collusive equilibrium, the retailer finds it optimal to fully dominate the market. Focusing on small enough values of σ ensures that $q(p^*, q(p^*)) > 0$, such that when R_i deviates from collusion, R_j still sells a positive quantity.

Collusion without vertical contracts is therefore possible if:

$$\frac{\pi^*}{1-\delta} > \pi^D + \frac{\delta}{1-\delta}\pi_R^C \quad \Leftrightarrow \quad \delta > \delta^C = \frac{(2-\sigma)^2}{8-\sigma(8-\sigma)}. \qquad (11)$$

It is straightforward to show that for $0 < \sigma < 0.73$, $1/2 < \delta^C < 1$ and δ^C is increasing with σ. Next, we turn to the case where retailers have secret vertical contracts with the supplier and we ask whether retailers can use these contracts in order to maintain a collusive equilibrium for $\delta < \delta^C$. We construct a collusive equilibrium in which in every period the two retailers offer the supplier in the first stage the secret contract (w^*, T^*) that the supplier accepts, and then in the second stage the two retailers set the collusive price p^*. As in our base model, suppose that any observable deviation at period t triggers the perfectly competitive equilibrium from period t +1 onwards. In this section we focus on the competitive equilibrium in which each retailer offers the supplier $w_i = T_i = 0$ and then the two retailers charge p^C and earn π_R^C while the supplier earns $\pi^C = 0$.[24]

The collusive contract has to satisfy two conditions. The first condition is that once retailers offered a contract (w^*, T^*) that the supplier accepted, R_i indeed plays in stage 2 the collusive price, p^*, instead of deviating to R_i's short-run best response to p^*. Let $p_i(p^*; w^*)$ denote the p_i that maximizes R_i's profit given $p_j = p^*$ and given w^*, $(p_i - w^*)q_i(p_i, p^*)$, where: [25]

$$p_i(p^*; w^*) = \tfrac{1}{4}(2 - \sigma + 2w^*).$$

The first necessary condition is therefore:

$$\begin{aligned} &(p^* - w^*)q^* + \frac{\delta}{1-\delta}\big((p^* - w^*)q^* - T^*\big) \geq \\ &\big(p_i(p^*; w^*) - w^*\big)q_i(p_i(p^*; w^*), p^*) + \frac{\delta}{1-\delta}\pi_R^C, \end{aligned} \tag{12}$$

where the left hand side is R_i's profit from maintaining collusion and the right hand side is R_i's profit from deviating. Notice that (12) is the equivalent of condition (2) for the case where retailers are differentiated.

Next, we move to the second condition regarding the collusive contract, which involves the supplier's participation constraint. Suppose that at the beginning of a certain period, both retailers offered the supplier the collusive contract (w^*, T^*). If the supplier accepts both offers, the supplier earns in the current period $2(w^*q^* + T^*)$ and collusion continues to the next period. Suppose, however that the supplier decides to deviate from collusion by rejecting one of the offers, say, the offer of R_2. R_1 cannot observe this deviation in the second stage of the period, and will therefore set $p_1 = p^*$. Let $q(p^*,\infty)$ denote the quantity that R_1 sells when it charges $p_1 = p^*$ and consumers cannot buy from R_2. We can solve for $q(p^*,\infty)$ by substituting $q_2 = 0$ and $p_1 = p^*$ into the utility of the representative consumer in (10) and differentiating with respect to q_1. Hence, we obtain that $q(p^*,\infty) = 1/2$. The supplier earns $w^*q(p^*,\infty) + T^*$ from this deviation in the current period, but then collusion stops in all future periods. The supplier's participation constraint is therefore:

$$\frac{2(w^*q^* + T^*)}{1-\delta} = w^*q(p^*,\infty) + T^*. \tag{13}$$

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[24] Our approach is consistent with O'Brien and Shaffer (1992) who find that when two differentiated retailers sign secret vertical contracts with a joint supplier, there is a unique "negotiation proof" contract equilibrium in which retailers set $w = T = 0$ and then charge the competitive prices.

[25] By our assumption that σ is not too high, when R_i deviates from the collusive price, R_i does not fully monopolize the market.

Condition (13) is the equivalent of condition (3) for the case where retailers are differentiated.[26] Solving (13) for T^* yields:

$$T^* = -\left[\frac{1-\sigma+\delta(1+\sigma)}{2(1+\delta)(1+\sigma)}\right]w^*. \tag{14}$$

The term in the squared brackets in (14) is positive, implying that $T^* < 0$ whenever $w^* > 0$. We can rewrite the supplier and retailers' one-period profits as a function of w^* as:

$$\pi_R(w^*) = \frac{1}{4(1+\sigma)} - \frac{(1-\delta)\sigma}{2(1+\sigma)(1+\delta)}w^*, \qquad \pi_S(w^*) = \frac{(1-\delta)\sigma}{1+\delta+\sigma+\delta\sigma}w^*. \tag{15}$$

As in our base model, $\pi_R(w^*)$ is decreasing in w^* while $\pi_S(w^*)$ is increasing in w^* and $\pi_S(w^*) > 0$ if and only if $w^* > 0$

It is possible to extend the proof of proposition 1 and show that conditions (12) and (13) are sufficient for a collusive equilibrium when retailers are differentiated. In the retailers' most profitable collusive equilibrium, retailers choose the lowest possible $w^* > 0$ that satisfies (12) and (13). Substituting (14) into (12) and rearranging, (12) becomes:

$$\left[\frac{\pi^*}{1-\delta} - \pi_R^D + \frac{\delta}{1-\delta}\pi_R^C\right] + \gamma w^*(\Omega - w^*) > 0, \tag{16}$$

where

$$\Omega \equiv \tfrac{\sigma(1-\delta+2\delta\sigma)}{1+\sigma} > 0, \quad \gamma \equiv \tfrac{1}{4(1-\sigma^2)} > 0.$$

Comparing (16) with the inequality that defines δ^C in (11) yields that when $w^* = 0$, the term in the squared brackets in (16) is positive if and only if $\delta > \delta^C$ and consequently so is (16). However, when $w^* > 0$, it is possible to satisfy (16) even when the term in the squared brackets is negative, i.e., for $\delta < \delta^C$, as long as

$$\frac{\pi^*}{1-\delta} - \pi_R^D + \frac{\delta}{1-\delta}\pi_R^C > -\frac{\gamma\Omega}{4}. \tag{17}$$

In such a case, $w^* > 0$ must involve $T^* < 0$, because of (14). Let δ^{VC} denote the solution to (17) in equality. The above discussion yields the following result:

[26] Notice that the right-hand-side of (16) is positive, because $q(p^*,\infty) > q^*$ and $w^*q^* + T^* > 0$.

Proposition 2: *Suppose that retailers are horizontally differentiated according the representative consumer's preferences in* (10) and $\sigma\in(0, 0.73]$. *Then,*

- *(i)* *For* $\delta\in[0, \delta^{VC}]$ *there is no collusive equilibrium;*
- *(ii)* *For* $\delta\in[\delta^{VC},\delta^{C}]$ *there are collusive equilibria. The retailers' most profitable collusive equilibrium involves* $w^* > 0$ *and* $T^* < 0$*;*
- *(iii)* *For* $\delta\in[\delta^{C},1]$ *there are collusive equilibria. The retailers' most profitable collusive equilibrium involves* $w^* = 0$ *and* $T^* = 0$*.*

Proposition 2 shows that when retailers are differentiated, secret vertical contracts can facilitate collusion, in that they enable retailers to sustain a collusive equilibrium for values of δ under which collusion is impossible without vertical contracts. Figure 2 plots δ^C and δ^{VC} as a function of σ for $\sigma\in(0, 0.73]$. In the region below δ^{VC}, there is no collusive equilibrium and the two retailers earn the competitive profit π_R^C while the supplier earns 0. In the region between δ^{VC} and δ^C, firms can maintain a collusive equilibrium with $w^* > 0$ and $T^* < 0$, and all three firms earn positive profits. It is possible to show that as in our base model, in this region, the retailers' profits increase with δ while the supplier's profit decreases with δ. In the region above δ^{VC}, the two retailers can collude without including the supplier in the collusive scheme. In this region, retailers set $w^* = T^* = 0$, collude on the monopoly price, and each retailer earns half of the collusive profit while the supplier earns 0.

Recall that in the base model with homogeneous retailers, the retailers and the supplier can maintain a collusive equilibrium for all positive values of δ. Proposition 2 shows, by contrast, that when retailers are differentiated, the three firms cannot maintain a collusive equilibrium when δ is sufficiently small. As retailers become closer substitutes, however, (i.e., σ increases), δ^C increases, δ^{VC} decreases and consequently the region in which vertical contracts with slotting allowances facilitate collusion increases. The intuition for these two results is that retailers' differentiation makes it costly for the supplier to reject a deviating contract offer from a retailer, because by doing so the supplier does not gain access to certain consumers. This feature decreases the supplier's market power, which in turn decreases its ability to police the two retailers' adherence to the collusive equilibrium. This is why as retailers become more differentiated, collusion becomes harder to sustain, even when retailers use vertical contracts.

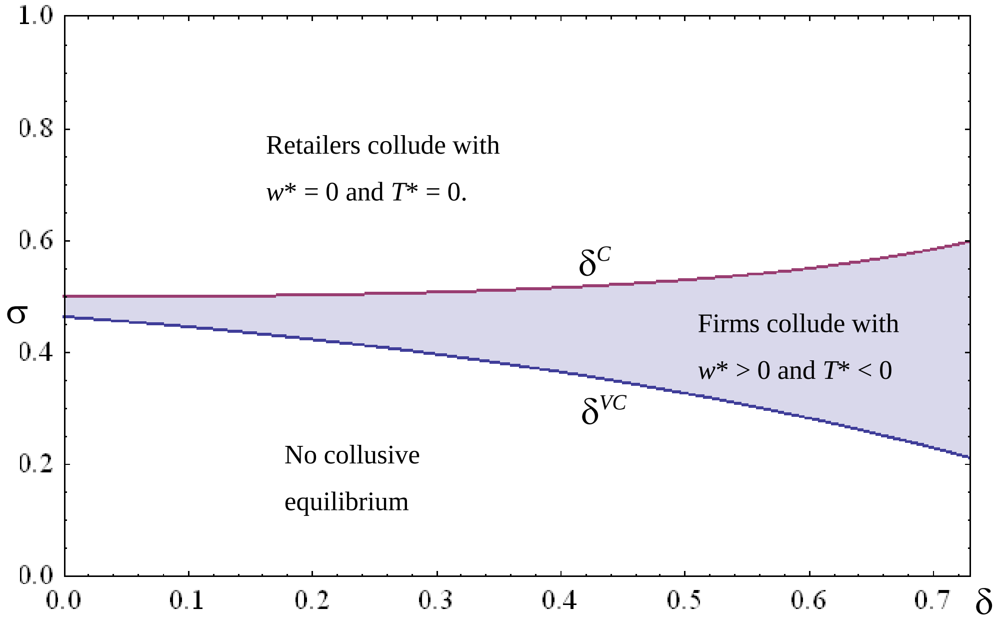

Figure 2: The cutoffs δ^{C} and δ^{VC} as a function of σ

6. Conclusion

We consider collusion in a dynamic game between retailers buying from a joint supplier. Our model has two main features. First, vertical contracts are secret: a retailer cannot observe the bilateral contracting between the competing retailer and the supplier. Second, all three firms care about the future. We find that the second feature compensates for the first: When all firms care about the future, even secret vertical contracts can facilitate downstream collusion.

The supplier gains from downstream collusion, because retailers need the supplier's active assistance in order to collude and they are accordingly willing to pay him higher wholesale prices than they otherwise would have paid him. This occurs even when retailers have all the bargaining power, where the supplier's difficulty in charging a high wholesale price is at its peak. Retailers, in turn, gain from committing to buy exclusively from the same supplier and granting him monopoly power. However, if retailer collusion breaks down, so does an attempt to buy exclusively from one supplier: retailers need some sort of external commitment device to be able to buy exclusively from one supplier so as to support their collusive scheme. It would be interesting to further explore whether sequential bargaining changes this result. Intuitively, sequential bargaining may have two conflicting effects on retailers' ability to maintain collusion. On one hand, if retailer 1 does not make an exclusive dealing offer to the dominant supplier, the dominant supplier, under the possibility of sequential bargaining, rejects retailer 2's offer (knowing that retailer 2 will make no sales if retailer 1 deviates). Then retailer 2 would buy from the competing supplier for a wholesale price equal to zero and prevent retailer 1's short-term profits from deviation. At the same time, sequential bargaining increases the retailers' bargaining power vis-à-vis the dominant supplier. The supplier expects that if it rejects a retailer's offer, the retailer has the ability to eliminate the supplier's profits by buying from the competing supplier. Which of these effects dominates will depend on the features of the bargaining procedure.

Finally, slotting allowances paid by the supplier to retailers are essential to make downstream collusion work. Such slotting allowances need not be exclusionary for them to be anticompetitive. They serve as a prize the supplier pays retailers in future periods for their adherence to the collusive scheme in previous periods.

Appendix

Below are the proofs of Lemma 1, Proposition 1 and Corollary 2.

Proof of Lemma 1:

We will proceed in two steps. In the first step, we will show that if (1) does not hold then R_i finds it optimal to deviate to a contract that motivates the supplier to reject the contract of R_j, but this deviation is impossible if (1) holds. In the second step we show that R_i cannot profitably deviate to a contract that does not motivate the supplier to reject the contract of R_j.

We first show that if (1) does not hold, R_i can make a profitable deviation. Since $p(w) > w$ and $pQ(p)$ is concave in p:

$$\max_{w_i}\{w_i Q(p(w_i))\} < \max_{w^C}\{w^C Q(w^C)\},$$

$$\max_{w_i}\{w_i Q(p(w_i))\} > w^C Q(w^C)\Big|_{w^C=0}, \text{ and: } \max_{w_i}\{w_i Q(p(w_i))\} < w^C Q(w^C)\Big|_{w^C=p^*},$$

implying that there is a w_L such that (1) holds for $w^C \in [w_L, p^*]$ and does not hold otherwise, where $w_L > 0$. Suppose that (1) does not hold. Then R_i can deviate to (T_i, w_i) such that $w_iQ(p(w_i)) > w^CQ(w^C)$. If the supplier accepts the contract, it rationally (for both the supplier and R_i) to expect that the supplier does not accept the contract of R_j and that R_i sets $p(w_i)$. Given these expectations, the supplier agrees to the deviating contract if $w_iQ(p(w_i)) + T_i \geq w^CQ(w^C)$, or $T_i = w^CQ(w^C) - w_iQ(p(w_i))$. R_i earns from this deviation:

$$\begin{aligned} &(p(w_i) - w_i)Q(p(w_i)) - T_i \\ &= p(w_i)Q(p(w_i)) - w^CQ(w^C) \\ &> w_iQ(p(w_i)) - w^CQ(w^C) \\ &> 0, \end{aligned}$$

where the first inequality follows because $p(w_i) > w_i$ and the second inequality follows because whenever (1) does not hold it is possible to find w_i such that $w_iQ(p(w_i)) > w^CQ(w^C)$. Since R_i earns in equilibrium 0, R_i finds it optimal to deviate. Now suppose that (1) holds. Then, there is no w_i that ensures that the supplier does not accept the contract of R_j.

Next, we turn to the second step of showing that R_i cannot make a profitable deviation when R_i expects that the supplier accepts the equilibrium contract of R_j. Suppose that R_i deviates to $(T_i, w_i) \neq (0, w^C)$ such that if the supplier accepts the deviation, the supplier continues to play the equilibrium strategy of accepting the contract offer of R_j, $(0, w^C)$. R_i therefore expects that R_j will be active in the market and will set $p^C = w^C$. The deviation can be profitable to R_i only if $w_i < w^C$, such that R_i can charge in stage 2 a price slightly lower than w^C and dominate the market. To convince the supplier to accept the deviating contract, R_i charges T_i such that the supplier is indifferent between accepting both offers and accepting just the equilibrium offer of R_j: $w_iQ(w^C) + T_i \geq w^CQ(w^C)$, or $T_i \geq (w^C - w_i)Q(w^C)$. But then R_i earns at most $(w^C - w_i)Q(w^C) - T_i \leq 0$. We therefore have that R_i cannot offer a profitable deviation from the equilibrium (0, w^C) if R_i believes that the supplier accepts the equilibrium contract of R_j.

Proof of Proposition 1:

We will move in three steps. In the first step we solve for the set of (w^*, T^*) that satisfy (2), (3) and $\pi_S(w^*) \geq \pi^C$. In the second step we show that the set of (w^*, T^*) ensures that R_i cannot profitably deviate to $(w_i, T_i) \neq (w^*, T^*)$. We will assume wary beliefs such that R_i expects that the supplier accepts the contract of R_j only if it is profitable for the supplier to do so. In Lemma *A1* we will show that if the supplier expects that by accepting both R_i's deviating offer and R_j's offer R_i will defect from collusion, then the supplier will not accept both offers to begin with. This implies that if the supplier accepts a deviating offer by R_i in the first stage of a certain period, the supplier accepts the equilibrium offer of R_j only if the supplier expects that R_i will maintain collusion at the second stage. We can therefore restrict attention to the following two cases that we examine in Lemma *A2* and Lemma *A3*. Lemma *A2* shows that R_i cannot profitably deviate to a contract $(w_i, T_i) \neq (w^*, T^*)$ such that if the supplier accepts the deviating offer of R_i, the supplier also accepts and the equilibrium offer of R_j and then R_i continues to maintain collusion. We do not impose constraints on the set of possible (w_i, T_i) that ensures that R_i indeed maintains collusion given the deviating contract because we show that even the unconstrained set of (w_i, T_i) is never profitable for R_i. In Lemma *A3* we show that R_i cannot profitably deviate to a contract $(w_i, T_i) \neq (w^*, T^*)$ such that if the supplier accepts the deviating offer of R_i, the supplier does not accept and the equilibrium offer of R_j. Again we show that this holds for any (w_i, T_i) and therefore we do not need to impose restrictions on the set of possible (w_i, T_i) that support such beliefs. In the third step we solve for the (w^*,T^*) that maximizes the retailers' profits subject to (2), (3) and $\pi_S(w^*) \geq \pi^C$.

Starting with the first step, extracting T^* from (3) yields:

$$T^*(w^*) = \frac{\delta(\pi^C - Q^* w^*)}{(1+\delta)}. \tag{A-1}$$

Substituting (A-1) into (3) we can rewrite (2) as:

$$w^* > p^* - \frac{2\delta^2 (p^* Q^* - \pi^C)}{(1-\delta)Q^*}. \tag{A-2}$$

Substituting (A-1) into $\pi_S(w^*)$ we have:

$$\pi_S(w^*) = \frac{1-\delta}{1+\delta} w^* Q^* + \frac{2\delta}{1+\delta}\pi^C > \pi^C \quad \Leftrightarrow \quad w^* > \frac{\pi^C}{Q^*}. \tag{A-3}$$

Comparing the right-hand-sides of (A-2) and (A-3), the former is higher than the latter iff $\delta < 1/2$. We conclude that (2), (3) and $\pi_S(w^*) \geq \pi^C$ hold for any $T^*(w^*)$ defined by (A-1) and w^*, where:

$$w^* \geq w^E \equiv \begin{cases} p^* - \dfrac{2\delta^2(p^*Q^* - \pi^C)}{(1-\delta)Q^*}; & \delta \in [0, \tfrac{1}{2}]; \\ \dfrac{\pi^C}{Q^*}; & \delta \in [\tfrac{1}{2}, 1]. \end{cases}$$

Next, we turn to the second step of showing that the set of $w^* \geq w^E$ and $T^*(w^*)$ ensures that R_i cannot profit from deviating to another $(w_i, T_i) \neq (w^*, T^*)$.

We first show that given that the supplier accepts a deviating offer by R_i, the supplier does not accept the equilibrium contract of R_j if the deviating contract motivates R_i to deviate from the collusive price in the second stage of the period.

Lemma *A1*: *Suppose that in the first stage of a certain period R_i offers a deviating contract $(w_i, T_i) \neq (w^*, T^*)$ that motivates R_i to deviate from the collusive price at the second stage of the period. Under wary beliefs R_i cannot rationally expect that if the supplier accepts R_i's contract, the supplier also accepts the equilibrium contract offer of R_j.*

Proof: We will show that for all $w^* \geq w^E$, $T^*(w^*) \leq 0$. Consequently, the supplier cannot make positive profits from R_j by accepting both offers because the supplier expects that R_j cannot make positive sales while accepting the offer of R_j result in paying: $-T^*(w^*)$. To see why $T^*(w^*) \leq 0$, for $\delta < 1/2$:

$$T^*(w^*) = \frac{\delta(\pi^C - Q^*w^*)}{1+\delta} \leq \frac{\delta(\pi^C - Q^*w^E)}{1+\delta} = -\frac{\delta}{1-\delta}(1-2\delta)(p^*Q^* - \pi^C) < 0,$$

where the first inequality follows because $w^* \geq w^E$ and the second inequality follows because $\delta < 1/2$ and $p^*Q^* > \pi^C$. For $\delta > 1/2$, $T^*(w^*) \leq T^*(w^E) = T^*(\pi^C/Q^*) = 0$.

Lemma *A1* implies that if the supplier accepts a deviating offer by R_i in the first stage of a certain period, the supplier accepts the equilibrium offer of R_j only if the supplier expects that R_i will maintain collusion at the second period. Below we show that if there is such a deviating contract, $(w_i, T_i) \neq (w^*, T^*)$, R_i will not offer it. We do not impose constraints on (w_i, T_i) that support these beliefs but show that given any (w_i, T_i) that support these beliefs, the deviation is not profitable to R_i.

Lemma ***A2*****:** *Suppose that in the first stage of a certain period R_i offers a deviating contract $(w_i,T_i) \neq (w^*, T^*)$ such that the supplier and R_i expects that if the supplier accepts the deviation, the supplier also accepts the offer of R_j and R_i maintains collusion in the second stage of this period. Than, R_i cannot profit from making such a deviation.*

Proof: Suppose that the supplier and R_i have the common beliefs that if the supplier accepts the deviation, the supplier also accepts the offer of R_j and R_i maintains collusion. Whenever R_i makes this deviation, the supplier expects that R_i will set p^* in the current period and therefore R_j will not detect it. The supplier's profit from accepting the deviation depends on whether the supplier expects that R_i will offer in the next period the equilibrium contract or continue offering the deviating contract. We consider each possibility in turn. Suppose first that the supplier expects that R_i offers a one-period deviation, (w_i, T_i), and will continue offering (w^*,T^*) in all future periods. The supplier anticipates that by accepting this contract, this deviation will not be detected by R_j and therefore collusion is going to maintain in future periods. Therefore, the supplier accepts the deviation iff:

$$\begin{aligned}&w^*Q^*/2+T^*(w^*)+w_iQ^*/2+T_i+\frac{\delta}{1-\delta}\left(w^*Q^*+2T^*(w^*)\right)> \\ &w^*Q^*+T^*(w^*)+\frac{\delta}{1-\delta}\pi^C,\end{aligned} \tag{A-4}$$

where the left-hand-side is the supplier's profit from accepting a one-period deviation given that doing so maintains the collusion equilibrium in all future periods and the right-hand-side is the supplier's profit from accepting R_j's contract and stopping collusion. Substituting (A-1) into (A-4) and solving for T_i, the supplier accepts the deviation if:

$$T_i>\frac{\delta}{1+\delta}\pi^C+\frac{1-\delta}{2(1+\delta)}Q^*w^*-\frac{Q^*w_i}{2}. \tag{A-5}$$

R_i prefers making this one-period deviation if R_i earns higher one-period profit than the equilibrium profit. However, R_i's profit from this deviation is:

$$(p^*-w_i)Q^*/2-T_i<\tfrac{1}{2}\left(p^*-\frac{1-\delta}{1+\delta}w^*\right)Q^*-\frac{\delta}{1+\delta}\pi^C=\pi_R(w^*). \tag{A-6}$$

where the inequality follows from substituting (A-5) into T_i in (A-6). Notice that we only need to look at the one-period profit because if the supplier accepts the deviation then R_i's future profits are $\pi_R(w^*)$. We therefore have that R_i cannot profit from making the deviation. Suppose now that the supplier expects that R_i's deviation is permanent. Now, the supplier agrees to the deviation if:

$$\frac{w^*Q^*/2 + T^*(w^*) + w_iQ^*/2 + T_i}{1-\delta} > w^*Q^* + T^*(w^*) + \frac{\delta}{1-\delta}\pi^C ,$$

where the left-hand-side is the supplier's profit from accepting the deviation given that the supplier expects that the deviation is permanent and the right-hand-side is identical to (A-4). The supplier agrees to the deviation if:

$$T_i > \frac{\delta}{1+\delta}\pi^C + \frac{1-\delta}{2(1+\delta)}Q^*w^* - \frac{Q^*w_i}{2} . \tag{A-7}$$

R_i's profit from making this deviation in the current and all future periods is:

$$\frac{(p^* - w_i)Q^*/2 - T_i}{1-\delta} < \tfrac{1}{1-\delta}\left(\tfrac{1}{2}\left(p^* - \frac{1-\delta}{1+\delta}w^*\right)Q^* - \frac{\delta}{1+\delta}\pi^C\right) = \frac{\pi_R(w^*)}{1-\delta} , \tag{A-8}$$

where the inequality follows from substituting T_i in (A-7) into (A-8). We therefore have that R_i cannot profitably make a permanent deviation to (w_i, T_i) that motivates R_i to maintain collusion.

Next we turn to the last deviating option for R_i, which is to deviate to a contract such that if the supplier accepts the deviation, the supplier does not find it profitable to accept the equilibrium contract of R_j. In the following lemma we show that if there is such a deviating contract, (w_i,T_i) $\neq$(w^*, T^*), R_i will not offer it. As with Lemma *A2*, we do not impose constraints on the set of (w_i, T_i) that support these beliefs but show that given any unconstrained set of (w_i, T_i) that support these beliefs, the deviation is not profitable to R_i.

Lemma *A3*: *Suppose that in the first stage of a certain period R_i offers a deviating contract* (w_i,T_i) $\neq$(w^*, T^*) *such that if the supplier accepts the contract, the supplier does not accept offer of R_j. Than, R_i cannot profit from making such a deviation.*

Suppose that R_i deviates to (w_i, T_i) given the beliefs that if the supplier accepts the deviation, the supplier rejects the contract of R_j. The supplier accepts the deviation if $w_iQ(p(w_i)) + T_i > w^*Q^* + T^*(w^*)$, or:

$$T_i > w^*Q^* - w_iQ(p(w_i)) + T^*(w^*) . \tag{A-9}$$

R_i earns from this deviation:

$$
\begin{aligned}
&(p(w_i) - w_i)Q(p(w_i)) - T_i \\
&< p(w_i)Q(p(w_i)) - w^* Q^* - T^*(w^*) \\
&= Q^*\left(p^* - \frac{w^*}{1+\delta}\right) - \frac{\delta}{1+\delta}\pi^C \qquad , \\
&< \frac{\pi_R(w^*)}{1-\delta}
\end{aligned}
\tag{A-10}
$$

where the first inequality follows from substituting the right-hand-side of (A-9), the equality follows from substituting (A-1) and the second inequality holds iff $w^* > w^E$, implying that this deviation is not profitable for R_i for $w^* > w^E$.

Finally, we turn to the last step of solving for the collusive equilibrium that maximizes the retailers' profits subject to (2), (3) and $\pi_S(w^*) > \pi^C$. From (4), $\pi_R(w^*)$ is decreasing with w^* and therefore the most profitable equilibrium is $w^* = w^E$. Substituting w^E into (A-1) yields (5) and (6).

Proof of Corollary 2:

Suppose that retailers have choose a collusive equilibrium subject to the constraint $T(w^*) \geq 0$. From (A-1), $T(w^*) \geq 0$ requires $w^* \leq \pi^C Q^*$. However, (3) requires that $w^* > w^E > \pi^C Q^*$ where the last inequality holds for all $\delta < 1/2$. Therefore, it is impossible to obtain a collusive equilibrium with $T^*(w^*) > 0$ for $\delta < 1/2$.

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