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Manufacturer Collusion and Resale Price Maintenance

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Abstract

We provide a theory of harm for resale price maintenance (RPM) when manufacturers collude. In a model with two manufacturers and two retailers, we show that RPM facilitates manufacturer collusion when retailers have an outside option to selling a manufacturer's product. Because of the outside options, manufacturers can only ensure that retailers sell their products by leaving sufficient retail margins. This restricts the wholesale price level even when the manufacturers collude. RPM allows colluding manufacturers to establish higher prices. The use of renegotiation-proof RPM stabilizes collusion whereas otherwise RPM can decrease the range of discount factors which enable stable collusion.

JEL classification: D43, K21, K42, L41, L42, L81.

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1 Introduction

Resale price maintenance (RPM) has been used by colluding manufacturers of beer, gummi bears, chocolate, and coffee in Germany.[1] The case reports contain indications that RPM helped to make manufacturer collusion successful. Regarding these cases, Germany's competition authority (Bundeskartellamt) states:

> 'Most of the fines imposed in the proceedings concerned infringements relating to confectionery, coffee and beer. In these cases, the infringements were particularly anti-competitive and anti-consumer, because horizontal agreements between the manufacturers, which were also sanctioned by the Bundeskartellamt, were accompanied by vertical price-fixing measures in which major retailers participated.'[2]

A recent report by an OECD roundtable also describes cases where colluding manufacturers struggled to convince retailers to accept higher wholesale prices absent price coordination through RPM.[3] Holler and Rickert (2021) illustrate that the coffee cartel apparently only became successful in sustaining higher wholesale prices when the coffee producers started using RPM in addition to coordinating their wholesale prices.

It is not straightforward why RPM would facilitate manufacturer collusion in these cases. For an upstream cartel, jointly increasing the wholesale prices should be an option if prices are too low from its perspective. Why is it helpful to control the retail prices as well? While the suspicion that RPM facilitates collusion is not only backed by recent cases but is also prevalent in competition policy circles,[4] there is still very limited economic theory in support of this link between RPM and collusion. The work of Jullien and Rey (2007) is a notable exception. They show that RPM can facilitate upstream collusion when retailers face privately observed shocks on demand or costs. Without RPM, a drop in demand can induce retailers to cut the retail price. Other manufacturers may mistakenly think that the manufacturer is deviating from the cartel agreement, leading to a price war. With RPM, manufacturers can prevent such ambiguous retail price cuts and thereby stabilize their cartel. However, private information and sudden retail price cuts do not appear to be the main driver for the use of RPM in at least some of the above-mentioned cases, such as the coffee cartel.[5]

[1] The cases concern Anheuser Busch, Haribo, Ritter, and Melitta; (last access 2020/02/03).

[2] See the Bundeskartellamt's press release "Fine proceedings for vertical price fixing in the German food retail sector concluded" of December 15, 2020 (last access 2020/02/03).

[3] 'Roundtable on Hub-and-Spoke Arrangements – Background Note by the Secretariat 3-4 December 2019'; OECD; (last access 2020/02/03). Similarly, there have been instances where manufacturers helped retailers to coordinate on higher retail prices through hub-and-spoke cartels and organizing information exchanges.

[4] 'Roundtable on Hub-and-Spoke Arrangements – Background Note by the Secretariat 3-4 December 2019'; OECD; (last access 2020/02/03).

[5] We discuss the coffee cartel more in detail in section 6.

We start with the question why colluding manufacturers would facilitate retail price increases which presumably reduce demand. Increasing the wholesale price appears to be a more attractive alternative for colluding manufacturers if, from their perspective, the retail prices are too low. We provide a model in which manufacturers do not find it profitable to increase the wholesale prices even if they prefer higher retail prices, as at a higher wholesale price the retailers would not sell the product. The reason is that manufacturers need to ensure that the retailers make sufficient profits with their products to have an incentive to sell. In other words, retailers have (opportunity) costs of selling a manufacturer's product.

We set up a model to study the link between RPM and manufacturer collusion that is suggested by the above competition policy cases. This differs from the classical hub-and-spoke cartel where retailers ask a manufacturer to coordinate retail prices, which can also involve the use of RPM. In our model there are two competing manufacturers, each making a two-part tariff offer to their exclusive retailer, similar to Piccolo and Reisinger (2011). We consider a repeated game in which manufacturers may use trigger-strategies to collude while retailers are short-lived and thus cannot collude. The key addition in our model is that the retailers have outside options, which are valuable alternatives to accepting the manufacturer's contract and selling its product. For instance, a retailer may have limited shelf space and thus needs to decide whether to stock one or the other product. One can also interpret the outside options as a degree of bargaining power at the retail level.

In this setting where retailers have relevant alternatives to selling a manufacturer's product, manufacturers have to offer sufficiently low wholesale prices for the retailer to sell their products. We compare manufacturer competition to manufacturer collusion with and without resale price maintenance. Our main finding is that collusion may only be effective, that is, yield higher prices than manufacturer competition, if the manufacturers can use RPM. RPM tends to increase the manufacturers' profits under collusion but to decrease their profits under competition. This indicates that RPM may, in certain settings, only be desirable for manufacturers when they collude.

We derive our results with a model of competition between two vertical supply chains in which the manufacturers use two-part tariff contracts and make secret but interim-observable take-it-or-leave-it offers. Each retailer has a fixed outside option to the contract which is sunk after contract acceptance and an outside option to selling the product. Whereas the outside option to contract acceptance can be covered by fixed transfers, the outside option to selling limits the wholesale price that a manufacturer can set. This simple approach with fixed outside options helps to highlight the mechanism of how RPM can facilitate manufacturer collusion.

Besides the price level, RPM can affect the stability of collusion – measured by the range of discount factors that support a collusive equilibrium. In the cases where collusion is not feasible absent RPM, the use of RPM enables and – in this sense – also stabilizes collusion. In the cases where, at least to some degree, supra-competitive prices are feasible without RPM, the use of RPM can stabilize collusion by increasing the collusive profits and decreasing the competitive profits. However, RPM may increase the deviation profits as well which, in general, makes the overall effect of RPM on stability ambiguous. If some degree of collusion is feasible without RPM, the effects of RPM on the deviation profits depend on how retailers can react to a retail price cut of a manufacturer that deviates from the collusive arrangement. If the retailers do not need to adhere to RPM of non-deviating manufacturers, as this is not in the interest of these manufacturers, RPM does not increase the deviation profits and thus clearly stabilizes collusion. We call this renegotiation-proof RPM which means that a manufacturer only enforces the retail price prescribed by RPM if that yields a higher manufacturer profit than the retail price which the retailer attempts to set in a given situation. If, instead, the retailers need to adhere to RPM of a non-deviating manufacturer even if this hurts the manufacturer, a deviation from collusion is more profitable with RPM than absent RPM.

Following the related literature in section 2, we set up the model in section 3 and solve it in section 4. Section 5 contains a model extension to illustrate how our results can be maintained with multi-product retailers. We describe the above mentioned coffee cartel case more in detail in section 6 and relate our model to this case. Finally, we conclude in section 7 with a discussion of competition policy implications.

2 Related literature

Our setting with two manufacturers and two exclusive retailers is similar to the one in Piccolo and Reisinger (2011) who also study interim-observable contract offers with two-part tariffs that become observable to all retailers just before the retailers set their prices. We extend the model by allowing the retailers to have outside options to accepting the contract and to selling of a manufacturer's product. Furthermore, we compare the competitive outcome to the outcome under manufacturer collusion with and without RPM. For the stage game with manufacturer competition, we find that the use of RPM can result in a dilemma for the manufacturers in the sense that they would be better off if RPM was banned. This is in line with the results of Rey and Stiglitz (1995) and Bonanno and Vickers (1988) for vertical integration, which has similar effects on pricing as RPM in our setting.

Besides the aforementioned article of Jullien and Rey (2007), a strand of literature studies how the retail organization affects manufacturer collusion but it does not analyze RPM (Reisinger and Thomes, 2017; Piccolo and Reisinger, 2011; Liu and Thomes, 2020). Reisinger and Thomes (2017) compare multi-product retailers with exclusive retailers and Liu and Thomes (2020) study vertical integration versus delegation. Piccolo and Reisinger (2011) show that, compared to a situation of perfect retail price competition, exclusive territories tend to make manufacturer collusion easier as the manufacturers benefit from instantaneous retail price reactions when a manufacturer deviates from the collusive agreement and cuts its wholesale price. In the framework of Piccolo and Reisinger (2011), RPM would have the same effect as perfect retail price competition and would thus be rather detrimental to manufacturer collusion.[6]

Other related articles study different vertical aspects of collusion. Nocke and White (2007) study the effects of vertical integration on collusion and Gilo and Yehezkel (2020) demonstrate that collusion involving the monopoly manufacturer can be easier to sustain than collusion among only the retailers. Schlütter (2022) studies the effects of price parity clauses on seller collusion on a sales platform when the sellers also have a direct sales channel.

Rey and Vergé (2010) show that resale price maintenance can result in higher prices without collusion in a static setting of interlocking vertical relations, where multiple manufacturers sell through competing common retailers. Different from our model, their result relies on observable two-part tariff contracts that allow manufacturers to internalize the total industry profits. Dobson and Waterson (2007) consider a model where manufacturers negotiate linear wholesale prices with retailers. In this context, RPM can increase the equilibrium market prices, particularly when retailers have strong negotiation power. Neither Rey and Vergé nor Dobson and Waterson study collusion but focus on one-shot games.

In our model, the market power of each manufacturer is limited by an outside option of each retailer that can be interpreted as a cost of providing promotional services for the manufacturer's product. In so far, our argument is related to the literature on retail services. According to the service argument, which goes back to Telser (1960) and was refined by Mathewson and Winter (1984) alongside others, a monopoly manufacturer may use RPM in order to improve the service incentives of its retailers. Similar to Hunold and Muthers (2017), the opportunity cost of selling a product might be driven by an outside option of promoting different products. For example, the 'service cost' of a supermarket for selling a coffee brand could be the opportunity cost of not being able to use the shelf space (and possibly the space in the promotional flyer) for other products. Asker and Bar-Isaac (2014) highlight the externality of vertical restraints on competing manufacturers and show that different vertical restraints can prevent market entry at the manufacturer level. Similarly, Dertwinkel-Kalt and Wey (2020) show in a setting with linear tariffs that a single manufacturer can benefit from RPM when selling to a multi-product retailer who also sells a product of a competitive fringe. RPM increases the retail margin and thus can incentivize the multi-product retailer

[6] In their analysis, RPM is equivalent to the baseline case of perfect competition between retailers.

to increase the price of the fringe product.

Colluding manufacturers may face the same type of problems as an upstream monopolist. When an upstream monopolist lacks the ability to publicly commit to the vertical contracts, it is tempted to secretly make each retailer an offer with a competitive wholesale price (opportunism). This limits the manufacturer's ability to realize monopoly profits (Hart et al., 1990; Segal, 1999). Rey and Vergé (2004) show that RPM can solve the opportunism problem. Gabrielsen and Johansen (2017) add retail services and show that a monopoly manufacturer can evade the opportunism problem only with public commitment to industry-wide RPM but not with purely vertical price controls. We abstract from potential opportunism problems of colluding manufacturers in the present article. Opportunism problems and the formation of collusion are the topics of our companion project Gieselmann et al. (2021) where the contract offers are unobservable and where we solve for perfect Bayesian Nash equilibria instead of subgame perfect Nash equilibria.

Schinkel et al. (2008) point to a different reason, an 'Illinois Wall' why colluding manufacturers want to provide rents to retailers. Their argument applies to a context where cartel damage claims are limited to direct purchasers of a cartel. When the cartel provides rents to a direct purchaser, it ensures their cooperation and reduces the risk of detection.

3 Model

We study contracting and pricing in a vertically related market with two symmetric manufacturers and two symmetric retailers. We consider an infinitely repeated stage game with discrete time. We focus on manufacturer collusion and abstract from retailer collusion and vertical types of collusion. The manufacturers are infinitely lived and share a common discount factor $\delta \in (0, 1)$, whereas the retailers are short-lived and maximize spot profits.

Procedure

We compare the market outcomes under manufacturer competition and collusion both with and without RPM. The retailers compete in any case. We number the four scenarios as depicted in Table 1.

Manufacturers	without RPM	with RPM
compete	(I)	(II)
collude	(III)	(IV)

Table 1: Scenarios of our analysis

In this section, we set up the stage game which is sufficient for analyzing the scenarios I and II of manufacturer competition. In the collusive scenarios III and IV, the manufacturers collude using symmetric grim-trigger strategies.

Contracting and pricing in the stage game

Assume that each retailer is an exclusive seller of one of the manufacturer's products. Demand for product i at retailer i is given by a symmetric function $D_i(p_i, p_{-i})$. We assume all costs of production and distribution (except for the payments of the wholesale contract) to be zero, as this simplifies the expressions and does not affect our results. The manufacturer offers contracts with a two-part tariff wholesale contract (we relax the assumption on exclusivity later on). The fixed part of the two-part tariff can be negative, i.e., a payment to the retailer. In some industries like groceries, such payments are commonly referred to as slotting fees.

Timing of the stage game and equilibrium. A key element of our model is the outside option that each retailer has. We differentiate between an outside option to the contract acceptance and an outside option to selling the product. With fixed transfers the manufacturers can satisfy the outside option to accepting the contract. This is not the case for the outside option to selling the product.

Within each period, there is a stage game with the following timing:

1. Each manufacturer $i \in \{A, B\}$ offers its retailer a two-part tariff contract: a wholesale price $w_i \geq 0$ and franchise fee F_i paid to manufacturer i; with RPM also a retail price p_i.[7]

2. Each retailer i observes its contract offer, accepts the offer of its manufacturer i or rejects it. In case of rejection, the retailer receives a fixed outside option value of Δ.

3. Each retailer that has accepted its contract offer decides whether to sell the product or not sell the product and realize an outside option of value Ω.

4. All supply contracts are disclosed to all retailers. Absent RPM, retailers sets their prices (p_i) simultaneously.

Following for instance Piccolo and Reisinger, 2011, we assume that the wholesale prices only become observable in stage 4 and solve for subgame perfect Nash equilibria, which avoids certain technical complications.[8]

[7] We model RPM as a fixed price that the manufacturer sets. One can then study whether, in equilibrium, this effectively amounts to a price floor or a price ceiling.

[8] There are two prime alternative information structures. First, full secrecy of the contracts up

Profits. The profit of retailer i when accepting the contract and selling the product of manufacturer i is

$$\pi_i - F_i = (p_i - w_i) \cdot D_i\left(p_i, p_{-i}\right) - F_i,$$

and the profit of manufacturer i is

$$\Pi_i = w_i \cdot D_i(p_i, p_{-i}) + F_i.$$

Retailers' outside options. Our main results are based on the idea that fixed payments may not suffice to incentivize retailers to sell a product. The parameter Ω encompasses these (opportunity) costs of selling the product after contract acceptance. Once a retailer has accepted the contract and paid the fixed fee, it might still have shelf space opportunity costs, marketing costs of selling product i, and other retailing opportunity costs. We treat the outside option as exogenous, such that it is not affected by the prices in the market. If one modeled the outside option as selling the other manufacturer's product, it would depend on the price of that manufacturer and generally would be depend on the intensity of manufacturer competition.[9] The fixed outside option can straightforwardly be interpreted as the value a retailer would obtain from not advertising the product, using the shelf and storage space for other products, or not educating its sales personal about the product. One may also think about the outside option as the possibility of a retailer to stock a perfect substitute to the manufacturer's product with a marginal cost of $c > 0$, i.e., selling a "private label".[10] In line with this, one can interpret the outside options as a degree of bargaining power at the retail level. For instance, there is evidence of strong bargaining power of supermarkets that could be the result of a relevant outside option at the retail level. For instance, German and Swiss supermarkets banned many products of Nestlé, a large food and beverages producer, from their shelves as a result of the supply contract negotiations in which supermarkets did not accept increased wholesale prices.[11]

The outside option Ω can also resemble costs for retail services, such as pre-sales advice, as found in the literature on the service argument (as summarized in Mathewson and Winter (1998)); the difference here is that these costs of selling the product

to the retailers' pricing decisions necessitates to include retailers' beliefs about rival retailers offers (Hart et al., 1990; Rey and Vergé, 2004). This can result in opportunism of colluding manufacturers which we investigate in Gieselmann et al. (2021). Second, public contracting as in Rey and Vergé (2010) implies that one manufacturer can foreclose its rival by marginally undercutting the candidate equilibrium prices, leading to non-existence problems of equilibria.

[9] If the only reason for a retailer's outside option to selling the product of manufacturer A was selling the product of manufacturer B, this outside option value might vanish once both manufacturers offer collusive input prices.

[10] Please see section 5 of the discussion paper version Hunold and Muthers (2020) for this extension.

[11] Reuters, 2018/04/06, Supermarkets Edeka and Coop expand Nestle boycott (last access 2022/06/24).

are not proportional to the sales volume but rather a fixed amount that is necessary for selling this product. An example for the latter could be the costs of paying a sales assistant for being present in the store. From a technical point of view, a fixed outside option at the sales stage simplifies the analysis. By this we also abstract from the question of whether a change in the level of retailer services due to RPM is socially desirable as the results in the literature are mixed. In general, retail services can be under-provided absent RPM if this service exerts positive externalities on the manufacturer and competing retailers (Winter, 2009). RPM can have socially desirable effects if it aligns the incentives between retailers and manufacturers with the result of better services and higher sales. However, with competing manufacturers the use of RPM may harm consumers and mainly shift rents to the retailers with the consequence of higher retail prices (Hunold and Muthers, 2017). Moreover, in the case of simple groceries, such as filter coffee, it might be less obvious that there would be too little retail services absent RPM, especially if compared to more complex products such as hearing devices.

In addition to the (opportunity) costs of selling the product after contract acceptance (Ω), a retailer might have additional (opportunity) costs of accepting the contract, which are captured by the difference $\Delta - \Omega$. For example, these may stem from not being able to accept and process a contract of another product At contract acceptance, the retailer anticipates both the opportunity costs of selling the product and the potentially additional costs that result from the pure contract acceptance. Hence, we collect all opportunity costs before contract acceptance in the parameter Δ and make the natural

Assumption 1. $\Delta \geq \Omega > 0$.

The weak inequality $\Delta \geq \Omega$ reflects the potentially additional (opportunity) costs before contract acceptance, such as the time it takes to conclude the contract. The reverse inequality would mean that the retailer is surprised by the profit it has to forego in order to sell the product which he did not anticipate at contract acceptance. The above assumption excludes this case but it allows for the case where $\Delta = \Omega$. The strict inequality $\Omega > 0$ means that retailers do not sell products if that yields them zero incremental profits.

Differentiation between these outside options would be superfluous if negative transfers (such as slotting fees) were not possible at all or to a large enough degree, as then selling and contract acceptance both have to be incentivized only with the unit wholesale price w_i. Negative fees might be implausible for other reasons, for instance, if slotting fees are prohibited by law. They might also be inefficient if the manufacturer cannot distinguish between retailers who actually want to sell the product and others that would only cash in on the fixed transfer.

Assumptions on demand and profits

Let us first consider the retailers' price setting without RPM after each retailer has accepted the manufacturer's contract. Each retailer faces a wholesale price w_i and both retailers set prices simultaneously, each solving the problem to

$$\max_{p_i} (p_i - w_i) D_i (p_i, p_{-i}) - F_i.$$

In equilibrium, the retailers set a pair of prices $p_i(w_i, w_{-i})$ that are mutual best-responses. We assume that the pricing game has a unique equilibrium. We make

Assumption 2. *The reduced profit of each retailer, $\pi_i(w_i, w_{-i})$, is monotonically decreasing in the own wholesale price w_i and monotonically increasing in the competitor's wholesale price w_{-i}.*

Moreover, for the case where both retailers accept the manufacturers' contracts and the wholesale prices are equal ($w_A = w_B = w$), we focus on a symmetric equilibrium in the retailing subgame and make

Assumption 3. *The competitive downstream price level $p_i(w_i, w_{-i})$ increases in the wholesale prices: $\frac{\partial p_i(w_i,w_{-i})}{\partial w_i} > 0$ and $\frac{\partial p_i(w_i,w_{-i})}{\partial w_{-i}} > 0$. The retail profit $\pi_i(w, w)$ decreases in the symmetric wholesale price $w = w_A = w_B$, and $\pi_i(0, 0) > \Delta$.*

The last part of the assumption implies that it is always profitable for the industry to sell the product. On the upstream profits we make

Assumption 4. *Absent RPM, a manufacturer's reduced profit, $\Pi_i(w_i, w_{-i})$, which takes the retailers' equilibrium pricing into account, gives rise to well-defined reaction functions that are strictly increasing and have a slope below one.*

This assumption ensures that the wholesale pricing game has a unique and stable equilibrium. Because this is an assumption on the reduced manufacturer profits, it entails implicit assumptions on the demand function. These assumptions are standard and are satisfied with, for instance, demand functions where the relationship between quantities and prices is linear. For auxiliary computations we use the linear demand function

$$D_i (p_i, p_{-i}) = 1 - p_i + \gamma (p_{-i} - p_i), \tag{1}$$

with $\gamma > 0$. A higher value of γ corresponds to a higher substitutability of the two products at the two retailers.

We assume that each manufacturer only sells its product if that yields strictly positive profits.

Equilibrium. We solve the game for subgame perfect Nash equilibria (SPNE) and focus on the symmetric equilibria. We compare price competition among the manufacturers with manufacturer collusion, assuming that it is public knowledge whether using RPM is feasible or not.

4 Solution

We start by solving for the stage game SPNE under manufacturers competition – without and with RPM. Afterwards, we solve the super game and study collusion without and with RPM.

4.1 Retailer strategy (contract acceptance and pricing)

Let us first consider that the retailers set the retail prices. As the retailers are short-lived, their equilibrium strategy can be derived by solving for the stage game SPNE using backward induction. We start with stage 4, assuming that both retailers have stocked their manufacturer's product. In stage 4, retailers observe both wholesale prices and compete in retail prices. This results in a flow profit denoted by $\pi_i(w_i, w_{-i})$. These profits decrease in w_i and increase in w_{-i} as described in assumption 2.

Anticipating these flow profits, each retailer decides in stage 3 whether to sell the product. The retailer i sells its product if the following sales constraint holds:

$$\pi_i(w_i, w^*) \geq \Omega. \tag{2}$$

At this stage, each retailer only observers its own wholesale contract. In the subgame perfect Nash equilibrium, each retailer bases its sales decision on the correctly anticipated equilibrium wholesale price w^* of the other retailer.

The fixed transfer F_i is sunk at this stage. Hence, the sales decision depends only on the flow profits and thus the marginal wholesale prices of the manufacturers' contracts. Each manufacturer will have to take the sales constraint (2) into account to ensure that the retailer actually sells the product.

In stage 2, each retailer receives the contract offer of its manufacturer. Simultaneously, each of the retailers either accepts or rejects its contract offer. Each retailer accepts its contract if its expected profit exceeds the value of the outside option to the contract of value Δ. In stage 2, thus, each retailer accepts the contract if the following contract acceptance constraint holds:

$$\max(\pi_i(w_i, w^*), \Omega) - F_i \geq \Delta. \tag{3}$$

We simplify contract acceptance constraint (3) using the sales constraint (2) and summarize in

Lemma 1. *Without RPM each retailer accepts the contract and stocks the product if both the sales condition*

$$\pi_i(w_i, w^*) \geq \Omega \tag{4}$$

and the contract acceptance condition

$$\pi_i(w_i, w^*) - F_i \geq \Delta \tag{5}$$

hold.

Recall that we assume $\Delta \geq \Omega$, such that if both the sales and contract acceptance constraint bind, the fixed transfer will be (weakly) negative. This is often called a slotting fee.

4.2 No RPM and manufacturer competition (scenario I)

Consider the case that manufacturers offer contracts competitively and cannot use RPM, which is known by the retailers.

In stage 1 of the game, the manufacturers offer contracts simultaneously, anticipating the retailers' reactions. Suppose each manufacturer wants to ensure that its product is sold at its retailer. Each manufacturer solves

$$\max_{w_i, F_i} \Pi_i = w_i \cdot D_i(p_i(w_i, w_{-i}), p_{-i}(w_{-i}, w_i)) + F_i,$$

subject to the contract acceptance constraint

$$\pi_i(w_i, w^*) - F_i \geq \Delta \tag{6}$$

and the sales condition

$$\pi_i(w_i, w^*) \geq \Omega. \tag{7}$$

Which of the constraints is binding depends on the values of the different outside options. Note that F_i only affects the participation in the contract, not the incentive for selling the product once the contract is accepted. The manufacturer can ensure contract acceptance by choosing an appropriate F_i. Because the manufacturer's profits increase in F_i and F_i decreases the left hand side of the contract acceptance constraint, the participation must bind in equilibrium and defines F_i. Hence, the problem can be simplified to

$$\max_{w_i} \Pi_i = w_i \cdot D_i(p_i(w_i, w_{-i}), p_{-i}(w_{-i}, w_i)) \\ + (p_i(w_i, w^*) - w_i) \cdot D_i\left(p_i(w_i, w^*), p_{-i}(w^*, w_i)\right) - \Delta$$

subject to

$$\pi_i(w_i, w^*) \geq \Omega. \tag{8}$$

Whether the sales constraint is binding depends on the level of the outside option Ω. We analyze in turn the cases of a non-binding and a binding sales constraint.

Unconstrained marginal wholesale prices. For Ω sufficiently small, the sales constraint does not bind in the unconstrained case as $\pi_i(w^*, w^*) > 0$. The unconstrained case is equivalent to disregarding condition (8). This unconstrained case corresponds to a competitive equilibrium in the spirit of Bonanno and Vickers (1988) with positive wholesale margins. The symmetric equilibrium wholesale prices are then defined by the system of first order conditions of the wholesale prices and when setting all wholesale prices equal: $w_i = w^*$. This results in

$$\frac{\partial p_i(\cdot)}{\partial w_i} \cdot \left[\frac{\partial D_i(\cdot)}{\partial p_i} + D_i\left(\cdot\right)\right] + \frac{\partial D_i(\cdot)}{\partial p_{-i}} \frac{\partial p_{-i}(\cdot)}{\partial w_i} p_i\left(\cdot\right) = 0. \tag{9}$$

Denote by $w^U = w^* = w_i$ the symmetric unconstrained equilibrium wholesale price that solves equation (9). Equation (9) corresponds to the equilibrium condition in Bonanno and Vickers (1988), where the second, positive term captures the strategic delegation effect. The strategic delegation effect implies that wholesale prices are above marginal costs, such that prices are larger than they would be for an integrated supplier consisting of both manufacturer and retailer. We define the unrestricted competitive retail price absent RPM as

$$p^U = p(w^U, w^U)$$

and the corresponding manufacturer profit as

$$\Pi^U = p^U D_i(p^U, p^U) - \Delta.$$

Constrained marginal wholesale prices. For sufficiently large values of Ω, the sales constraint binds and defines the equilibrium wholesale prices. While the unconstrained price w^U is defined by a first order condition, the sales constraint puts an upper limit on w_i as the retail profits decrease in w_i. We define the equilibrium wholesale price in the constrained case as follows.

Definition. The constrained wholesale price $w^*(\Omega)$ is defined by the largest symmetric combination of wholesale prices w that satisfies the sales constraint

$$\pi_i(w, w) = \Omega. \tag{10}$$

It follows from assumption 3 and equation (10) that $w^*(\Omega)$ decreases in Ω. In equilibrium, the retailers observe and correctly anticipate wholesale prices of w^* and non-cooperatively set retail prices of

$$p^*(\Omega) = p(w^*(\Omega), w^*(\Omega)). \tag{11}$$

Thus, the retail prices decrease in the level of the outside option. The corresponding manufacturer profit is

$$\Pi^*(\Omega) = p^*(\Omega) \cdot D_i(p^*(\Omega), p^*(\Omega)) - \Delta.$$

The sales constraint binds if $w^U > w^*(\Omega)$ or, equivalently, if $p^U > p^*(\Omega)$. Hence, the equilibrium price is the minimum of p^U and $p^*(\Omega)$.

Manufacturers only offer contracts if they anticipate to make profits on the equilibrium path. This implies that the outside options must not be too valuable, such that $w^*(\Omega) > 0$ holds. Otherwise the profit of the retailers would not suffice to recover Ω and, in turn, Δ, such that selling would result in a loss for the manufacturers.

Proposition 1. *The equilibrium retail prices are not affected by the outside option to the contract Δ, but generally depend on the value Ω of the sales outside option.*

If Ω is sufficiently large, such that $p^U > p^*(\Omega)$: Under manufacturer competition, there is an equilibrium with retail prices of $p^*(\Omega)$ and wholesale prices of $w^*(\Omega)$, which both decrease in Ω. Manufacturer and industry profits decrease in Ω, whereas retailer profits increase.

If the sales outside option value Ω is low, such that $p^U \leq p^*(\Omega)$, the equilibrium prices are defined by equation (9)*. In both cases the marginal wholesale prices are strictly positive.*

Proof. See annex. □

Summary. Whenever the outside options of the retailers are sufficiently attractive, the prices are pinned down by the retailers' contract acceptance conditions and not by the level of manufacturer competition.

The equilibrium contracts entail fixed transfers to the retailers that cover the part of the outside option to the contract that is in excess of the opportunity cost of selling the product: $F^* = \Omega - \Delta \leq 0$. Hence, if there is no opportunity cost of signing the contract in excess of the cost of selling the product, the optimal tariff is linear. If for other reasons the supply contracts have to be linear ($F_i = 0$), the two outside options essentially boil down to one outside option of the value $\Delta = \max(\Omega, \Delta)$.

4.3 RPM and manufacturer competition (scenario II)

Suppose that both manufacturers use RPM and the retailers are aware of this. Confronted with manufacturer $i's$ contract offer w_i, F_i and p_i, retailer i chooses whether to accept and sell the manufacturer's product. We solve for the subgame perfect Nash equilibrium where each retailer correctly anticipates the contract terms offered to the rival retailer. Each retailer only has to decide whether to accept the contract (outside option value of Δ) and whether to sell the product (outside option value of Ω).

With RPM, each manufacturer can choose the retail price at a level that maximizes the joint profits with its retailer. As the outside options are fixed amounts, each manufacturer effectively maximizes the product line profit $p_i \cdot D_i(p_i, p_{-i})$ with respect to p_i. Instead, without RPM, the retailers set the retail prices based on positive input costs of $w_i > 0$.

Proposition 2. *Under manufacturers competition, the symmetric equilibrium retail prices are lower with RPM than without RPM:* $p^{RPM} < \min\left(p^*(\Omega), p^U\right)$. *The competing manufacturers make lower profits with RPM than without.*

Proof. See annex. □

The intuition behind the result is that with RPM each manufacturer directly controls prices and competes more directly with the other manufacturer than absent RPM. Without RPM there is a strategic delegation effect as each retailer faces a wholesale price above marginal costs and adds a margin to that, which dampens competition relative to direct price competition between manufacturers at the true and thus lower marginal costs.

4.4 Manufacturer collusion

The underlying idea for collusion is that the manufacturers can sustain higher wholesale prices by employing a dynamic strategy that punishes deviations to lower wholesale prices. We assume that the manufacturers collude on the wholesale prices (and, with RPM, also on the retail prices) using grim-trigger strategies to support an outcome that maximizes their joint profits. We focus on the case of symmetric collusion where the symmetric manufacturers collude on the same price level. In equilibrium, both manufacturers' contracts will be accepted and both products will be sold. Recall that we assume short-lived retailers and thus exclude retailer collusion.

With grim-trigger strategies, each manufacturer starts in period 0 offering the collusive contract. This results in profits of Π^C for each manufacturer. If one manufacturer deviates form offering the collusive contract, both manufacturers revert to offering the competitive contract in all future periods, which results in non-cooperative Nash profits of Π^N in each future period. In the deviation period, the deviating manufacturer can possibly earn higher profits, which we denote by Π^D. The reduced form incentive constraint for a manufacturer to stick to the collusive agreement is

$$\frac{\Pi^C}{1-\delta} \geq \Pi^D + \frac{\delta \Pi^N}{1-\delta}. \tag{12}$$

We refer to manufacturers as being patient enough when the discount factor δ with $\delta \in (0,1)$ is high enough for the stability condition to hold. The previous two sections 4.2 and 4.3 characterize the competitive Nash equilibria with the profits Π^N for the cases without and with RPM. Proposition 2 implies that the competitive profit without RPM is strictly smaller than the competitive profit with RPM.

For reference, the industry profit maximizing retail price level is

$$p^M \equiv \arg\max_p p \cdot D_i(p,p)$$

and the condition

$$p_i\left(w^M, w^M\right) = p^M \tag{13}$$

defines the wholesale price level w^M that yields p^M absent RPM. Condition (13) has a unique solution for w^M under assumption 3.

The highest profit that each manufacturer can obtain in a collusive period is

$$\Pi^M \equiv p^M \cdot D_i\left(p^M, p^M\right) - \Delta,$$

which equals the industry profit per product minus the retailer's outside option value to accepting the contract.

4.5 No RPM and manufacturer collusion (scenario III)

In stage 1 of the game, the manufacturers offer a collusive contract, denoted by $\left(w^C, F^C\right)$, that maximizes their joint stage game profits. The retailers know that the manufacturers cannot use RPM. To assess the stability condition (12), we derive the profits of the deviating manufacturer in a deviation period (Π^D) and period profit on the collusive path (Π^C). In case of punishment, the manufacturers revert to the competitive supply contracts as characterized in Proposition 1, yielding a manufacturer profit of Π^N.

Case (i): Outside options define competitive prices ($p^U \geq p^*(\Omega)$). Recall that the competitive manufacturer profit depends on whether the sales constraint, which is caused by the outside option Ω, binds. A similar case distinction arises under collusion. Let us first focus on the case that Ω limits the competitive price: $p^U \geq p^*(\Omega)$. We show for this case without RPM that even a perfectly working manufacturer cartel cannot implement a higher price than the competitive equilibrium price and cannot extract larger profits than under competition. Formally, this means that $\Pi^C = \Pi^D = \Pi^N$, which implies that collusion cannot increase profits without RPM.

As the manufacturers want to sell both products, they

$$\max_{w_A, w_B, F_A, F_B} \Pi_A + \Pi_B = \sum_{i=A,B} w_i \cdot D_i(p_i(w_i, w_{-i}), p_{-i}(w_{-i}, w_i)) + F_i,$$

subject to

$$\pi_i(w_i, w_{-i}) - F_i \geq \Delta, \forall i, \tag{14}$$

and

$$\pi_i(w_i, w_{-i}) \geq \Omega, \ \forall i. \tag{15}$$

Which constraint binds for a given contract offer (w_i, F_i) depends on the values of the different outside options, similar to the competitive case. Note that F_i only affects the contract acceptance condition, not the sales constraint. Hence, choosing an appropriate value of F_i satisfies the contract acceptance condition, whereas the sales constraint depends on the wholesale prices only. As the manufacturer profit increases in F_i whereas the left hand side of the contract acceptance condition decreases in F_i, the latter condition must bind with equality in equilibrium and defines F_i. This simplifies the problem to

$$\max_{w_A, w_B, F_A, F_B} \Pi_A + \Pi_B = \sum_{i=A,B} w_i \cdot D_i(p_i(w_i, w_{-i}), p_{-i}(w_{-i}, w_i)) - \Delta, \tag{16}$$

subject to

$$\pi_i(w_i, w_{-i}) \geq \Omega, \forall i. \tag{17}$$

When neglecting condition (17), the unconstrained maximizer of (16) is w^M. The constraint (17) binds if $w^M \geq w(\Omega)$ or, equivalently, if $p^M \geq p^*(\Omega)$. Under manufacturer collusion, the sales constraint binds for lower values of Ω than under competition as $p^M \geq p^U$. Thus, in the case where $p^*(\Omega) \leq p^U$, the colluding manufacturers cannot raise prices, so that the competitive price level $p^*(\Omega)$ results, which implies that the profit of a colluding manufacturer is

$$\Pi(\Omega) = p^*(\Omega) \cdot D_i(p^*(\Omega), p^*(\Omega)) - \Delta,$$

which is the same as under competition. This implies that collusion is ineffective at increasing prices and profits, such that $\Pi^C = \Pi^D = \Pi^N = \Pi(\Omega)$.

Cases (ii) and (iii): Competitive prices not defined by outside options ($p^U < p^*(\Omega)$). There are two cases: the retailers' sales constraints either

- limit the collusive manufacturer profits (case (ii): $p^M > p^*(\Omega)$) or
- they do not (case (iii): $p^*(\Omega) \geq p^M$).

In case (iii), the outside option value Ω does not affect the equilibrium, such that a collusive profit $\Pi^C = \Pi^M$ is attainable and is strictly higher than the competitive profit Π^N. For the stability condition in this case, only the deviation profits Π^D are missing.

Suppose that manufacturer A sets the collusive price w^M in the current period while manufacturer B optimally deviates by setting w^D in best response to w^M. Retailer B observes w^D and correctly anticipates a wholesale price of w^M at the other manufacturer. When deciding about the contract, manufacturer B and retailer B thus both anticipate all prices and profits in the deviation period correctly and manufacturer B sets F_B such that $\pi_B - F_B = \Delta$. As there is strategic delegation in the sense that retailer A reacts to the rival's wholesale price w_B when setting the retail price p_A, the optimal deviation entails $w^D > 0$. We can write the unconstrained deviation profit of a manufacturer as

$$\Pi^D = p(w^D, w^M) \cdot D_i(p(w^D, w^M), p(w^M, w^D)) - \Delta.$$

This yields the usual profit ranking $\Pi^D > \Pi^C = \Pi^M > \Pi^N$ and implies a well defined critical patience level δ that makes collusion on the monopoly price stable.

Let us now turn to case (ii) where $p^M > p^*(\Omega)$. The period profits on the collusive path equal $\Pi^C = \Pi(\Omega)$. We denote $\bar{w}^D$ as the maximizer of the deviation profits, which yields deviation profits of

$$\Pi^D = p\left(\bar{w}^D, w(\Omega)\right) \cdot D_i\left(p(\bar{w}^D, w(\Omega)), p(w(\Omega), \bar{w}^D)\right) - \Delta.$$

Note that $\bar{w}^D < w^D$ holds as $\bar{w}^D$ is the best-response to a lower constrained wholesale price $w(\Omega)$ instead of w^M.

This again yields the order of $\Pi^D > \Pi^C > \Pi^N$, where now $\Pi^C = \Pi(\Omega)$.

We summarize in

Proposition 3. *Absent RPM, suppose the manufacturers collude using symmetric grim-trigger strategies.*

- *If the retailers' outside options bind under competition ($p^*(\Omega) \leq p^U$), the collusive wholesale prices equal the competitive prices of $w^*(\Omega)$ and the retail prices equal the competitive prices of p^*.*

- *If the ordering $p^U < p^*(\Omega) \leq p^M$ holds, the colluding manufacturers are limited by the retailers' outside options only and cannot achieve the industry profit maximizing outcome. There is a critical discount factor above which collusion on a wholesale price of $w^*(\Omega)$, which yields a retail price $p^*(\Omega)$, is feasible.*

- *If $p^U < p^*(\Omega)$ and $p^M < p^*(\Omega)$ hold, standard collusion at the monopoly level results if the manufacturers are sufficiently patient.*

The main insight is that the manufacturers, when colluding, may not be able to implement higher wholesale prices than under competition. The underlying intuition is that manufacturers do not have sufficient instruments to ensure simultaneously that

1. the retailers have the right incentives to stock and promote the products of manufacturer A and B instead of realizing the sales outside option, and that

2. the retail prices maximizes the industry profits.

Summary. Whenever the retailers' outside option binds under competition absent RPM, the resulting price level under collusion and competition is identical.

Remark (on symmetric versus asymmetric collusion). We focus our analysis on symmetric equilibria. When explicitly studying a repeated game, one could potentially construct an equilibrium with asymmetric collusion that yields larger profits than symmetric collusion and relies on only one manufacturer selling in each period. This could only be part of a collusive equilibrium if there are side payments between manufacturers or they could alternate whose product is accepted in-between periods. In such an equilibrium, because of product differentiation, there is some profit lost from not offering both products in the same period. Albeit these asymmetric equilibria may exist, we consider them unlikely to manifest in those markets that have motivated our theory, such as coffee sold at grocery stores as the alternating offers would be highly suspicious and difficult to implement. Besides the problem of relevant outside options of the retailers, alternating offers would also solve problems of asymmetric information of colluding firms, as in Jullien and Rey (2007) and Green and Porter (1984). Remarkably, these articles also focus on the simultaneous availability of the competing products.

4.6 RPM and manufacturer collusion (scenario IV)

Suppose manufacturers also set the retail prices (RPM) and collude on both a symmetric wholesale and retail price.

Collusive profit Π^C. On the collusive equilibrium path the manufacturers

$$\max_{w_A, w_B, p_A, p_B, F_A, F_B} \Pi_A + \Pi_B = \sum_{i=A,B} w_i \cdot D_i(p_i, p_{-i}) + F_i,$$

subject to the contract acceptance condition

$$(p_i - w_i) D_i(p_i, p_{-i}) - F_i \geq \Delta, \forall i, \tag{18}$$

and the sales condition

$$(p_i - w_i) D_i(p_i, p_{-i}) \geq \Omega, \ \forall i. \tag{19}$$

Similar to before, the manufacturers can use F_i to satisfy condition (18) with equality, which simplifies the problem to

$$\max_{w_A, w_B, p_A, p_B} \Pi_A + \Pi_B = \sum_{i=A,B} p_i \cdot D_i(p_i, p_{-i}) - \Delta,$$

subject to

$$(p_i - w_i) D_i(p_i, p_{-i}) \geq \Omega, \ \forall i. \tag{20}$$

The wholesale price w_i is free to satisfy the sales condition, while $p_i = p_{-i} = p^M$ maximizes $\sum_i p_i \cdot D_i(p_i, p_{-i})$. Consequently, the collusive manufacturer profit equals $\Pi^C = \Pi^M$. The sales condition (19), which restricts the collusive wholesale price w^C, becomes

$$w^C \leq p^M - \frac{\Omega}{D_i(p^M, p^M)}. \tag{21}$$

Condition (21) implies that the wholesale price must not be too large to ensure that the retailers have incentives to sell the products post contract acceptance. There is a degree of freedom as the manufacturers can compensate a lower wholesale price with a higher fixed fee.

Deviation profit Π^D. Our baseline assumption is that an RPM clause in the contract for product i binds retailer i in stage 4, independent of whether this is in the interest of manufacturer i and retailer i. An alternative assumption is that a manufacturer only enforces RPM in stage 4 when it is in its interest. This distinction does not matter on the collusive path but leads to different outcomes in case of a deviation when a retailer observes an unexpected price of the competing product in stage 4.[12] We analyze the alternative assumption in section 4.7 and use the baseline assumption in this section.

Under the assumption that the non-deviating retailer has to set the collusive RPM price, a deviating manufacturer

$$\max_{p_i, w_i, F_i} \Pi_i = w_i \cdot D_i(p_i, p^M) + F_i,$$

subject to

$$(p_i - w_i) D_i(p_i, p^M) - F_i \geq \Delta \tag{22}$$

and

$$(p_i - w_i) D_i(p_i, p^M) \geq \Omega. \tag{23}$$

Similar to before, this problem simplifies to

$$\max_{p_i, w_i} \Pi_i = p_i \cdot D_i(p_i, p^M) - \Delta,$$

subject to

$$(p_i - w_i) D_i(p_i, p^M) \geq \Omega. \tag{24}$$

This results in an optimal deviation price of

$$p^D = \arg\max_{p_i} p_i \cdot D_i(p_i, p^M)$$

and deviation profit for the manufacturer of

$$\Pi^D = p^D \cdot D_i(p^D, p^M) - \Delta.$$

Again, due to the fixed fee, there is a degree of freedom in the wholesale price, which must satisfy

$$w^D \leq p^D - \frac{\Omega}{D_i(p^D, p^M)}.$$

Proposition 4. *If the manufacturers use RPM and, in addition, collude on both the wholesale price and the retail price, the resulting symmetric retail price is p^M. The collusive wholesale price w^C must be small enough to satisfy the sales condition* (21)*.*

[12]The non-deviating manufacturer enforces RPM at a price p^M even though it would be better off letting the retailer choose a best response, ideally with a wholesale price of $w = 0$ such that interests in the vertical chain are aligned.

Each manufacturer makes a profit of Π^M*. Collusion is stable if the manufacturers are sufficiently patient such that condition* (12) *holds.RPM increases the collusive manufacturer profits if the retailers' outside options constrain the manufacturers absent RPM, i.e.,* $p^M \geq p^*(\Omega)$*.*

Proof. See above. □

4.7 Stability of collusion and welfare

Table 2 summarizes the effects of RPM on manufacturer collusion in terms of the resulting retail prices, the manufacturer profits, and the required critical level of patience for stable collusion ($\hat{\delta}$).

	Effect of RPM ..		
Cases of collusion absent RPM (below)	**.. on collusive retail prices**	**.. on collusive manufacturer profits**	**.. on stability of collusion ($\hat{\delta}$)**
(i) Outside options define competitive and collusive prices ($p^M > p^U \geq p^*(\Omega)$)	Up	Up	Up (no collusion absent RPM)
(ii) Outside options define collusive prices ($p^M > p^*(\Omega) > p^U$)	Up	Up	See propositions 5 and 6.
(iii) Unrestricted collusive pricing ($p^*(\Omega) > p^M > p^U$)	None	None	

Table 2: Effects of RPM on collusive market outcome.

Retail prices and profitability: RPM increases the collusive price when the retailers' sales outside option has bite. When the manufacturers collude, RPM has a price effect whenever the collusive price absent RPM would be limited by the outside option Ω: $p^M > p^*(\Omega)$. This condition holds in cases (i) and (ii) , such that RPM yields higher prices on the collusive equilibrium path (Table 2). This has a clear distributional implication. Recall that the retailers make the same profit in all scenarios as their contract acceptance constraint $\pi_i - F_i = \Delta$ binds in each equilibrium. Hence, when the retail prices increase in the direction of the industry profit maximizing price p^M, the manufacturer profits increase while consumer surplus decreases.

Corollary 1. *When the competitive wholesale prices are restricted by the retailers' outside options, the use of RPM in the case of manufacturer collusion increases the retail prices and reduces consumer surplus.*

The retailers' outside options are the core ingredient to our model. If they do not matter, RPM does not facilitate collusion in the present setting. Note that we do not explicitly account for the possible effects of retail services on demand and consumer surplus here. RPM can stimulate retail services which, depending on the market, may or may not be socially desirable.[13]

Critical discount factor: Does RPM make collusion more stable? In case (i), the competitive retail price absent RPM is constrained by Ω, so that collusion cannot increase prices. RPM is thus necessary for effective collusion and, in that sense, helps make collusion stable.

In cases (ii) and (iii), the sales outside option (Ω) does not constrain the competitive price absent RPM, such that collusion can increase prices. The effect of RPM on the stability of collusion can be ambiguous in these cases. Recall the stability condition

$$\frac{\Pi^C}{1-\delta} \geq \Pi^D + \frac{\delta \Pi^N}{1-\delta} \tag{25}$$

depends on three different profits. Let us explain the effects of RPM on them in the cases (ii) and (iii).

- Π^N: RPM leads to a lower punishment profit in any case. This effect of RPM stabilizes collusion.

- Π^D: Suppose the collusive price equals p^C both with and without RPM. When manufacturer B deviates, the reaction of retailer A depends on RPM:

  - Absent RPM: Manufacturer B cuts the wholesale price in stage 1. Retailer B accepts the contract in stage 2. In stage 4, both retailers see the collusive wholesale price w_A and the lower wholesale price w_B. Compared to the collusive level, both retailers set a lower retail price, with the order $p_B < p_A < p^C$.
  - With RPM: Manufacturer B cuts the retail price p_B in stage 1 and adjusts the fixed fee and/or wholesale price, so that retailer B still can expect to make a profit of Ω and accepts the contract in stage 2. In stage 4, both retailers see the collusive retail price $p_A = p^C$ and the lower retail price $p_B = \arg\max p_B D_B(p_B, p^C)$.

[13]For instance, a monopoly manufacturer may induce too much retail services than is socially desirable as the manufacturer cares for the marginal consumer when maximizing profits whereas the social surplus depends the benefits and costs for all consumers (Schulz, 2007).

- At the same collusive price level (as in case (iii)), the deviation profit is higher with RPM, provided the non-deviating retailer has to stick to the collusive price due to RPM. If the collusive price absent RPM is lower, the deviation profit absent RPM is even lower. This effect of RPM destabilizes collusion.

- Π^C: In case (iii), there is no relevant ex-post outside option (Ω small enough), such that the wholesale prices are unconstrained and the manufacturers can effectively collude at industry profit maximizing prices even without RPM, resulting in a profit of Π^M with and without RPM. In case (ii), absent RPM the collusive profit is below the profit Π^M obtainable with RPM. In this case, RPM stabilizes collusion through a higher collusive profit.

We summarize in

Proposition 5. *RPM leads to higher collusive prices (weakly so in case (iii) where $p^*(\Omega) > p^M$). In case (i) where $p^M > p^U \geq p^*(\Omega)$, RPM enables and thus also stabilizes collusion. In the cases (ii) and (iii) where $p^*(\Omega) > p^U$, the aggregate effect of RPM on the stability of collusion is generally ambiguous:*

- *RPM stabilizes collusion as the punishment profits Π^N are lower and the collusive profits Π^C are (weakly) higher.*

- *If a non-deviating retailer has to set the collusive price due to RPM, the deviation profit Π^D is higher with RPM, which destabilizes collusion.*

In the cases (ii) an (iii) and under the assumption of linear demand (equation (1)), collusion is stable in a smaller range of discount factors with RPM than without it.

Proof. See the annex for the critical discount factors with linear demand. □

Whether, on balance, RPM stabilizes collusion in the cases (ii) and (iii) depends the differences between the profits in periods of collusion, competition, and deviation as these determine the critical discount factors. These profits depend on the demand elasticity at different price levels. For example, the degree of substitution between the products influences the size of the delegation effect and this influences the difference between the profits in the punishment phase with and without RPM. With linear demand, it turns out that RPM reduces the parameter space of stable collusion in the cases (ii) and (iii).

Unambiguous stabilization if RPM binds only when it is renegotiation-proof. The only reason why RPM may not stabilize collusion is that RPM may increase the incentives to deviate (Π^D), as it stops the other retailer from reacting aggressively to an observed reduction on the wholesale price and retail price by the deviating manufacturer. However, in this case enforcing RPM is not renegotiation-proof for the non-deviating manufacturer as this manufacturer and its retailer would benefit from the retailer lowering the retail price in reaction to the deviation of the other manufacturer. To illustrate this case, let us make

Assumption 5. *If a retailer sets a retail price different from the price prescribed by RPM and this different price yields strictly higher profits for the manufacturer, the manufacturer does not enforce RPM in the sense that the manufacturer accepts the retail price.*

This assumption is not only plausible in the sense that it facilitates collusion and thereby increases profits. It is also plausible from a contract-law perspective in the sense that a manufacturer may not be able to claim damages if the retailer breaches the contract clauses of RPM in cases where this does not hurt but rather benefits the manufacturer.

Under this assumption we again construct a collusive equilibrium with RPM. In a nutshell, the only relevant change is a reduction of the manufacturer's deviation profit which makes collusion more stable with RPM than without it. Suppose that the manufacturers collude on retail prices of p^M, wholesale prices of zero and fixed fees that make retailers accept the contracts and sell the products. The resulting collusive period profit is again $\Pi^C = \Pi^M$. As before, in punishment periods, manufacturers revert to the Nash equilibrium of the stage game with competitive prices of $p^{RPM} = p_i(0,0)$. The punishment actions are robust to Assumption 5 that retailers may be able to deviate from RPM. A difference to before occurs in the deviation period where the manufacturers eventually do not enforce RPM. To prove that this stabilizes collusion, it is convenient to make

Assumption 6. *Absent RPM, the wholesale prices are strategic complements for the manufacturers, which implies increasing best-response functions at the manufacturer level: $\partial w_i / \partial w_{-i} > 0$.*

This is a plausible assumption in the case of price competition and results, for instance, with linear demand.[14]

Proposition 6. *If a manufacturer only enforces RPM when this increases its profit (Assumption 5) and wholesale prices are strategic complements (Assumption 6), RPM makes manufacturer collusion (weakly) more profitable and stable. There exists a collusive equilibrium with grim-trigger strategies and prices of $p^C = p^M$ and $w^C = 0$ on the equilibrium path that is stable for a larger range of discount factors than without RPM.*

[14] With the linear demand from equation (1), the best response function is given by $w_A^r(w_B) = \gamma^2 \left(\gamma^2 w_B + \gamma(w_B + 3) + 2\right) / \left(4(\gamma+1)^2 \left(\gamma^2 + 4\gamma + 2\right)\right)$, which clearly has a positive slope for $\gamma > 0$.

Proof. See annex. □

In summary, we find that RPM can facilitate collusion through a number of mechanisms. First, even without a relevant outside option of the retailers, RPM lowers the competitive manufacturer profits and thus increases the profitability of collusion relative to competition and increases its stability. Second, if absent RPM the retailers' outside options restrict the wholesale prices that the manufacturers can charge, RPM allows colluding manufacturers to achieve higher prices and profits. Finally, RPM can lead to lower deviation profits, which makes cheating less attractive. This occurs if the manufacturers do not enforce RPM when it is not in their individual interest.

For competition policy it is interesting to distinguish whether RPM is a price floor or a price ceiling. If used by colluding manufacturers, in our model RPM imposes retail prices above the level that a retailer would charge unilaterally. Thus, RPM acts as a price floor that increases retail margins and prices on the equilibrium path with collusion. In contrast, competing manufacturers use RPM to compress retail margins which undermines the strategic delegation effect. In this case RPM acts as a price ceiling for the retailers.

5 Multi-product retailer extension

Many retailers sell multiple brands of each product. We study now how multi-product retailing affects our results. For this, we sketch a simple extension of our model under which the results we obtained under single-product retailers qualitatively hold in a context of multi-product retailing.

In this extension each brand is sold at both retailers, which corresponds to the interlocking relationships of Rey and Vergé (2010). In line with Rey and Vergé (2010), we maintain the assumptions that manufacturers offer take-it-or-leave-it contracts. Recent alternative approaches, like Rey and Vergé (2019), feature more detailed negotiations between manufacturers and retailers and a more involved information structure.[15] However, we focus in this extension on showing how our main model extends to the case of multi-product retailers.

Set-up. We maintain the game of section 3 and modify it only in that each manufacturer now makes an offer to each retailer in stage 1. Each retailer, now denoted by index j, decides whether to accept none, one or two contracts in stage 2 and correspondingly what to sell in stage 3.

[15] Our key assumption is that the contract offered by the competing manufacturer does not impact the retailer's outside option. Taking that additional effect into account makes the analysis sensitive to assumptions on the timing and information structure of the contract offers that are beyond the scope of this extension.

This naturally yields demand functions where the demand for product i at retailer j is given by a function $D_{ij}(p_{ij}, p_{-ij}, p_{i-j}, p_{-i-j})$.

The profit of retailer j when selling both products is

$$\pi_j - F_A - F_B = \sum_{i\in\{A,B\}} (p_i - w_i) \cdot D_{ij}(p_{ij}, p_{-ij}, p_{i-j}, p_{-i-j}) - F_A - F_B,$$

and the profit of manufacturer i when selling to both retailers is

$$\Pi_i = w_i \cdot \sum_{j\in\{A,B\}} D_{ij}(p_{ij}, p_{-ij}, p_{i-j}, p_{-i-j}) + 2F_i.$$

Stage 3: sales decision. Suppose both retailers accepted both contracts which both contain a wholesale price of w and yield competitive retail prices of p. In general, retailer j can still decide between selling none, one, or both products. Retailer j prefers selling both products over selling none if

$$2\,(p-w)\,D_{ij}\,(p,p,p,p) \geq \Omega. \tag{26}$$

The retailer must also prefer selling two products over selling one:

$$2\,(p-w)\,D_{ij}\,(p,p,p,p) \geq (\tilde{p}_{ij} - w)\,D_{ij}\,(\tilde{p}_{ij}, \infty, \tilde{p}_{i-j}, \tilde{p}_{-i-j})\,, \tag{27}$$

where the demand on the right-hand side is evaluated at the retail prices which result in this case.

Stage 2: contract acceptance. Suppose a retailer faces two contracts which both contain a wholesale price of w and a fixed fee of F. We denote by p the symmetric, competitive price equilibrium when all wholesale prices are w. Each retailer decides whether to accept none, one, or both contracts. For retailer j to accept both contacts, provided retailer $-j$ does the same, retailer j must prefer accepting both contracts over the contract-outside option

$$\sum_i \left[(p-w)\,D_{ij}\,(p,p,p,p) - F\right] \geq \Delta \tag{28}$$

and over the alternative of selling only one product:

$$2\,(p-w)\,D_{ij}\,(p,p,p,p) - F \geq (\tilde{p}_{ij} - w)\,D_{ij}\,(\tilde{p}_{ij}, \infty, \tilde{p}_{i-j}, \tilde{p}_{-i-j}) - F. \tag{29}$$

Manufacturer pricing absent RPM. The difference to the case of single-product retailers is that D_{ij} depends on all four prices, such that each retailer, when selling both products, partially internalizes the brand competition when setting retail prices but not the retail competition. Intuitively, the unrestricted competitive price absent RPM (which arises when disregarding the outside options) are below the industry profit maximizing prices (p^M) if the intensities of manufacturer and retailer competition together are high enough (see Rey and Vergé (2010)). In a symmetric equilibrium, the competitive wholesale and retail prices are further restricted by the sales outside option value Ω when the latter is large enough, such that condition (26) binds with equality.

Suppose that condition (26) binds before condition (27). Without RPM, the sales condition (26) thus restricts the level of the wholesale and retail prices similarly to the case of single-product retailers. This is the case when the sales outside option value Ω is large enough relative to the flow profit of selling only one product. Intuitively, the latter is relatively small if the products are not too close substitutes. In this case, colluding manufacturers cannot increase the price level as increasing the wholesale price level would still prevent retailers from selling the products.

Remark 1. When the sales outside option value Ω is large enough, such that condition (26) binds with equality, the price level of colluding manufacturers is restricted absent RPM.

Manufacturer collusion with RPM. As with single-product retailers, colluding manufacturers can easily satisfy the sales condition (26) by setting sufficiently high retail and low wholesale prices. This allows to increase the industry profits while still satisfying the retailers' sales constraints.

Remark 2. Under the conditions specified in remark 1, RPM allows colluding manufacturers to increase the price level beyond the level that is feasible under collusion without RPM.

Although we have not provided a full equilibrium characterization for the case of multi-product retailers, the consideration highlights that, analogously to the case of single-product retailers, there is scope for RPM to help colluding manufacturers with implementing a higher price level.

A note on manufacturer competition with RPM. The results for competition with RPM depend on the demand assumptions: are brands or retailers closer substitutes? RPM shifts pricing to the manufacturers who internalize retailer competition but not brand competition. This compares to the case without RPM where retailers internalize brand competition but not retail competition. If the brands are close substitutes, RPM may still lead to lower manufacturer profits under competition. Recall from section 4.3 that there is an additional incentive for manufacturers to lower prices as they face lower marginal costs than the retailers who instead face wholesale price above marginal costs.

6 The coffee cartel's success with resale price maintenance

Key brand manufacturers formed a cartel in the period from 2003 to 2008 to coordinate their sale of coffee to supermarkets in Germany.[16] In the following we highlight some of the features of this cartel. The features of this case are likely shared by similar cartels on consumer goods sold through supermarkets, such as those mentioned in the introduction. Although we do not claim the out abstract theoretical model resembles all case details, we do consider it to have reasonable fit for the purpose of providing a theoretical explanation of RPM as a facilitating factor of manufacturer collusion in this industry.

We refer to Holler and Rickert (2021) for a more detailed case description and an econometric analysis of the price effects. Holler and Rickert use a home-scan consumer panel which tracks the purchasing decisions of 20,000 consumers from 2003 through 2009. They combine the data with information from detailed court decisions which contain extensive information on the cartel functioning. The decisions document interviews, testimonies, and email exchanges allow Holler and Rickert to reconstruct the date and the amount of wholesale and retail price increases. They use a before-after and a difference-in-differences approach where an unaffected cartel outsider serves as a control group that proxies how the cartel prices would have evolved without the cartel agreement.

Success of collusion with and without RPM. The brand manufacturers coordinated various wholesale price increases. According to the case descriptions, they had been coordinating wholesale price increases since 2003.[17] Initially, the success of the price increases was limited. Although the coordinated wholesale price increase of April 2003 was followed by price increases of some retailers, the retail prices dropped again after some time and the manufacturers took back the wholesale price increase in September 2003. - See the figures 1 and 3 in Holler and Rickert (2021) for a timeline and illustrative price plots.

The cartelists used RPM successfully since December 2004 and achieved higher price increases in the period from December 2004 to 2008. A central econometric finding of Holler and Rickert is that RPM led to a significant and lasting price over-

[16] OLG Düsseldorf, court decision 4 Kart 3/17 (OWi), February 18, 2018.

[17] Case report "Bußgelder wegen vertikaler Preisabsprachen beim Vertrieb von Röstkaffee" of the Bundeskartellamt, January 18, 2016.

charge, whereas the initial transitory price increase without RPM was much smaller. The cartel ended in 2008 after the German competition authority raided several coffee manufacturers.

Our theory explains the observation that the manufacturer cartel only became successful in sustaining higher prices with RPM. Moreover, we can also rationalize why the manufacturers started using RPM when they were coordinating their prices. Our theory predicts lower wholesale prices and manufacturer profits when the manufacturers use RPM without coordinating their wholesale prices when compared to a situation of wholesale price competition absent RPM.

Transparency. According to court evidence, for the limited number of brand manufacturers of coffee in Germany, transparency in the sales markets is high (par. 52).[18] Not only would the manufacturers have good visibility of the competitors' retail prices, the manufacturers would even have good visibility of the competitors' wholesale prices, as the retailers would inform the manufacturers of each others' wholesale conditions (par. 34).[19]

The evidence indicates that RPM would not be necessary for the manufacturers to overcome a lack of transparency of the retail market conditions and, most importantly, the wholesale prices of their competitors. These are the conditions under which Jullien and Rey (2007) show that RPM may facilitate collusion.

Moreover, the manufacturers having a high wholesale and retail price transparency and getting timely updates on the price changes of competitors speaks in favor of our model assumption of interim-observable wholesale tariffs that become fully visible to all players before the next period. The observation also indicates that the manufacturers can react very quickly if one of them undercuts a certain price level, which tends to facilitate collusion.

7 Conclusion

We started from the empirical observation that resale price maintenance (RPM) has been used by colluding manufacturers in various cases and appeared to be an important factor in making collusion successful. Studying these cases, we found that the explanation of Jullien and Rey (2007) does not seem to apply there as it relies on information asymmetries about demand, which we could not identify as a driving force.

In light of the case material, we developed a new theory of how RPM can facilitate upstream collusion absent any information asymmetries. For competition policy,

[18]OLG Düsseldorf, court decision V-4 Kart 5/11 (OWi) of February 10, 2014.

[19]OLG Düsseldorf (2004), see fn. 18 above.

our insights are relevant as they allow to rationalize the use of RPM by colluding manufacturers in recent policy cases referred to in the introduction.

Our key assumption is that retailers have an alternative to selling the manufacturers' products, such that manufacturers can only ensure that the retailers sell their products by leaving a sufficient margin to the retailers. This restricts the wholesale price level even when manufacturers collude. Our model features two competing manufacturers, of which each sells through an exclusive retailer. Each retailer has an outside option and manufacturers make secret but interim observable take-it-or-leave-it offers. Using a repeated game framework, we study manufacturer competition as well as collusion, both with and without RPM. We also illustrate how the insights can extend to the case of multi-product retailers.

We show that collusion may only be effective, that is, yield higher prices than competition, if the manufacturers can use RPM. The reason is that RPM allows the manufacturers to ensure sufficiently high retail margin on their products, even if the wholesale prices are at the collusive level. Otherwise, without RPM, selling the cartelized products at high wholesale prices becomes unprofitable for the competing retailers. We distinguish between the outside option to the contract and the outside option to selling the product, that is still relevant after contract acceptance. Whereas the outside option to the contract may be covered by fixed transfers, the outside option to selling requires sufficiently high retail margins.

Besides the price levels, we also analyze the effects of RPM on the stability of collusion. By increasing the collusive profits and decreasing the competitive profits, RPM stabilizes collusion. In certain cases, where some degree of collusion is feasible without RPM, the effects of RPM on the deviation profits depend on how retailers can react to a retail price cut of a manufacturer that deviates from the collusive arrangement. If the retailers do not need to adhere to RPM of non-deviating manufacturers, as this is not in the interest of these manufacturers, RPM does not increase the deviation profits and thus unambiguously stabilizes collusion. We call this renegotiation-proof RPM which means that a manufacturer only enforces the retail price prescribed by RPM if that yields a higher manufacturer profit than the retail price which the retailer attempts to set in a given situation. If, instead, the retailers need to adhere to RPM of a non-deviating manufacturer even if this hurts the manufacturer, a deviation from collusion is more profitable with RPM than absent RPM. In those cases where collusion is not feasible absent RPM, the use of RPM unambiguously stabilizes collusion.

Beyond our formal analysis that relies on the effective outside options of retailers, our theory addresses a general puzzle regarding the relevance of RPM for collusion. The more general insight is that an upstream cartel still suffers various fundamental problems regarding the coordination of competing downstream firms that also an upstream monopolist suffers. RPM is capable of solving some of these problems. These problems may be less of an issue when there is no, or only limited, market power upstream, such that RPM is less needed. Then, RPM can even intensify manufacturer competition and thereby reduce manufacturer profits. However, once the manufacturers collude and act similarly to an upstream monopolist, RPM becomes, quite generally, a desirable tool to increase collusive profits or even enable collusion at all. In light of this reasoning, competition authorities may thus take the prevalence of RPM as an indication of market power and, possibly, even collusion.

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Annex with proofs

Proof of proposition 1. Sales will occur on the equilibrium path and prices thus do not depend on Δ, the outside option to the contract, as $\pi_i(0,0) > \Delta$ (Assumption 3). Consider an equilibrium with binding sales constraint (equation (10) holds). This implies $\pi_i(w_{i.}^*, w_{-i}^*) = \Omega$ for $i = A, B$. In equilibrium, each manufacturer chooses the largest w_i that is compatible with the contract acceptance constraint of the retailer. Under Assumption 2, there is exactly one w_i for each w_{-i}.

With increasing best-response functions with a slope of less than one (Assumption 4), the best-response of each manufacturer is to choose $w_i > w_{-i}$ for any $w_{-i} < \min\{w^*(\Omega), w^u\}$. Thus, the wholesale price equilibrium is at $w_i = w_{-i} = w^*(\Omega)$, where no manufacturer has an incentive to increase the price, as this would violate the contract acceptance condition, and no incentive to lower the price, as its profits are maximized by choosing a price at least as large as the competitor for prices below the unconstrained equilibrium price level (w^U).

Any asymmetric combination of wholesale prices cannot be an equilibrium because for any combination that satisfies the binding sales constraint (10) for both retailers with $w_i < w_{-i}$, manufacturer i could increase its profit by increasing w_i. Thus, increasing w_i is profitable for the manufacturer with the lower wholesale price as long as the sales constraint of the retailer is satisfied. $\square$

Proof of proposition 2. The logic of the proof that $p^{RPM} < \min\left(p^*(\Omega), p^U\right)$ has two steps:

1. We show that $p^{RPM} = p(w = 0)$.
2. We show that $p^{RPM} < p^U$ and that $p^*(\Omega) > p(w = 0)$ by demonstrating that $p^*(\Omega) = p(\tilde{w})$ for some $\tilde{w} > 0$.

Given points 1 and 2 together, condition $p'(w) > 0$ (Assumption 3) implies $p^{RPM} < \min\left(p^*(\Omega), p^U\right)$.

Step 1: The problem for manufacturer i is to

$$\begin{aligned} \max_{w_i, p_i, F_i} \; & w_i \cdot D_i(p_i, p_{-i}) + F_i \\ \text{s.t.} (p_i - w_i) & D_i(p_i, p_{-i}) - F_i \geq \Delta \\ \text{and } (p_i - w_i) & D_i(p_i, p_{-i}) \geq \Omega \end{aligned}$$

where p_{-i} is the correctly anticipated retail price of the other product.

The second constraint always binds in equilibrium. For a given retail price p_i, the manufacturer will choose the highest possible w_i that just satisfies the constraint. This yields

$$\max_{p_i, F_i} (p_i \cdot D_i(p_i, p_{-i}) - \Omega) + F_i \tag{30}$$

$$\text{s.t.}\, \Omega - F_i \geq \Delta \tag{31}$$

$$\text{and } w_i = p_i - \Omega / D_i(p_i, p_{-i}) \tag{32}$$

The contract acceptance constraint always binds in equilibrium as well, due to the efficient rent transfer through the fixed fee. If it would not bind, the manufacturer would increase F_i until it binds. Solving constraint (31) with equality yields

$$F_i = \Omega - \Delta.$$

Recall here that $F_i \leq 0$ as we assumed $\Delta \geq \Omega$. Substituting in the objective function yields

$$\max_{p_i} p_i \cdot D_i(p_i, p_{-i}) - \Delta \tag{33}$$

$$\text{s.t.}\, F_i = \Omega - \Delta$$

$$\text{and } w_i = p_i - \Omega / D_i(p_i, p_{-i}).$$

The maximization problem with respect to p_i now corresponds to the one of a retailer without RPM for an wholesale price of $w_i = 0$. The equilibrium retail price of each manufacturer under competition with RPM is thus $p^{RPM} = p(w_i = 0, w_{-i} = 0)$.

Step 2: To show that $p^{RPM} < \min\left(p^*(\Omega), p^U\right)$, we show that both $p^*(\Omega)$ and $p^U$are prices resulting from $p(\tilde{w}, \tilde{w})$ for some $\tilde{w} > 0$.

For p^U, $\tilde{w} > 0$ follows from the logic of strategic delegation (Bonanno and Vickers, 1988). The first order condition for w^U is given by equation (9), that is

$$\frac{\partial p_i(\cdot)}{\partial w_i} \cdot \left[\frac{\partial D_i(\cdot)}{\partial p_i} + D_i(\cdot)\right] + \frac{\partial D_i(\cdot)}{\partial p_{-i}} \frac{\partial p_{-i}(\cdot)}{\partial w_i} p_i(\cdot) = 0. \tag{34}$$

We evaluate (34) at $p_i = p_{-i} = p^{RPM}$. The first term is zero, as the term in brackets is equivalent to the first order condition (FOC) under RPM. That is, equation (34) implies that the second term $\frac{\partial D_i(\cdot)}{\partial p_i} + D_i(\cdot)$ equals zero at p^{RPM}. However, the second term is positive for any positive price. In order for the FOC to hold, the price p^U that solves (34) must thus be larger than p^{RPM}, such that by concavity $\frac{\partial D_i(\cdot)}{\partial p_i} + D_i(\cdot) < 0$ holds. This implies $p^U > p^{RPM}$.

For $p^*(\Omega)$, $\tilde{w} > 0$ follows from the assumption that manufacturers only sell products if it is strictly profitable. Recall from equation (11) that $p^*(\Omega) = p(w^*(\Omega))$. Suppose that $w^*(\Omega) = 0$. The left hand side of equation (8) reduces to the industry profit:

$p(w^*(\Omega)) \cdot D_i\left(p(w^*(\Omega)), p(w^*(\Omega))\right) = \Omega$. The contract acceptance constraint of a retailer becomes $\Omega - F_i \geq \Delta$. As $\Delta \geq \Omega$, the manufacturers cannot make a positive profit when $w^*(\Omega) = 0$. Hence, $w^*(\Omega) > 0$ holds whenever the product is sold.

Retailers get a profit of Δ both with and without RPM. Thus introducing RPM affects both the industry and the manufacturer profits equally. As the price level absent RPM is below the monopoly level (that means $\min\left(p^*(\Omega), p^U\right) < p^M$), the manufacturers make less profit when they both use RPM compared to a situation without RPM as the retail prices are lower. □

Proof of proposition 5. The right-hand side of the rearranged stability condition

$$\delta \geq (\Pi^D - \Pi^C)/(\Pi^D - \Pi^N)$$

defines the critical discount factors, such that for larger discount factors than these threshold values collusion is stable. Using the linear demand function in equation (1) yields a critical delta for the case of collusion with RPM of

$$\hat{\delta}_{RPM}(\gamma) = \frac{(\gamma+2)^2}{\gamma^2 + 8\gamma + 8}.$$

Absent RPM, the critical value for case (iii) is

$$\hat{\delta}_{NoRPM}^{Case\,(iii)}(\gamma, \Omega) = \frac{\left(\gamma^2 + 6\gamma + 4\right)^2}{\gamma^4 + 20\gamma^3 + 84\gamma^2 + 96\gamma + 32}.$$

It holds that $\hat{\delta}_{RPM}(\gamma) > \hat{\delta}_{NoRPM}^{Case\,(iii)}(\gamma)$ under the assumption of substitutes ($\gamma > 0$).

The critical discount factor $\hat{\delta}_{NoRPM}^{Case\,(ii)}(\gamma, \Omega)$ is a lengthy parametric expression, which is available upon request. The condition which defines case (ii), that is $p^M > p^*(\Omega) > p^U$, implies an upper and lower bound of Ω. In particular, $p^*(\Omega) > p^U$ implies an upper bound of Ω and $p^M > p^*(\Omega)$ implies a lower bound. Under the linear demand assumption, this yields the condition

$$\frac{\left(\gamma^2 + 4\gamma + 2\right)^2}{(\gamma+1)\left(\gamma^2 + 6\gamma + 4\right)^2} > \Omega > \frac{1}{4 + 4\gamma}.$$

Under this condition, the inequality $\hat{\delta}_{RPM}(\gamma) > \hat{\delta}_{NoRPM}^{Case\,(ii)}(\gamma, \Omega)$ holds. This means that the critical discount factor with RPM is higher than the one without RPM in the cases (ii) and (iii). □

Proof of proposition 6. First, let us verify that the competitive equilibrium with RPM is not affected by Assumption 5. Consider the candidate equilibrium where both manufacturers set the price p^{RPM}, as defined in Proposition 2, and some wholesale price and fixed fee that ensure that the retailers sell the products. At wholesale prices of 0, each manufacturer and retailer agree on the optimal retail price as $p^{RPM} = p_i(w_i = 0, w_{-i} = 0)$. For $w_i > 0$, retailer i has a unilateral incentive to increase the retail prices above p^{RPM}, whereas manufacturer i would not accept a retail price increase and enforce RPM. The reason is that manufacturer i makes a profit of $w_i \cdot D_i(p_i, p^{RPM}) + F_i$ which, for a given F_i and w_i with $w_i > 0$, decreases in the own price p_i. As p^{RPM} is the mutual best response at the manufacturer level, there is no profitable unilateral deviation in prices by a manufacturer in the competitive equilibrium.

Second, suppose that manufacturers collude with grim-trigger strategies using RPM at $p^C = p^M$ and set $w_A = w_B = 0$. If the stability condition for a grim-trigger equilibrium at p^M holds, no manufacturer can benefit on the collusive path when its retailer changes the retail price as this would trigger eternal punishment. It is thus in each manufacturer's interest to enforce RPM.

Third, to see when the stability condition holds, let us analyze the period profit that a deviating manufacturer can obtain. Suppose manufacturer A deviates by lowering the price from p^M to some level $\hat{p}$ with $\hat{p} < p^M$. Both retailers observe the deviation in stage 4. Retailer B would benefit from lowering its retail price p_B in reaction to the decrease of p_A. In this case, it is in the interest of manufacturer B to not enforce RPM. Hence, for any price reduction by manufacturer A, both retailers anticipate that retailer B will not be bound by RPM. Under Assumption 5, also retailer A is only bound by RPM if that is in the interest of manufacturer A. Retailer A's optimal price is the best response to the anticipated price of retailer p_B. If this best response is below $\hat{p}$, manufacturer A will not enforce RPM as a lower retail price p_A (weakly) increases its profit. As a consequence, no manufacturer will enforce RPM in a deviation period.

Consider the following candidate equilibrium of the deviation period: No manufacturer enforces RPM in a deviation period and manufacturer A chooses a wholesale price $w_A = \hat{w} > 0$ while w_B is zero (as it is the case on the collusive equilibrium path). First, if manufacturer A increases w_A from 0 to $\hat{w} > 0$, it will not have an incentive to enforce minimum RPM. Hence, retailer A would choose its best-response resulting in a price, which would then characterize the equilibrium prices $(p_A(\hat{w}, 0), p_B(0, \hat{w}))$ in the deviation period. Next, we verify that $p^U > p_A(\hat{w}, 0) > p^{RPM}$.

To see that $\hat{w}$ satisfies $w^U > \hat{w} > 0$, consider the deviating manufacturer's problem to

$$\max_{w_A} \Pi_A = w_A \cdot D_A(p_A(w_A, 0), p_B(0, w_A)) + (p_A(w_A, 0) - w_A) \cdot D_A\left(p_A(w_A, 0), p_B(0, w_A)\right) - \Delta.$$

subject to

$$\pi_A(w_A, 0) \geq \Omega. \tag{35}$$

First note that by assumption $\pi_i(0,0) > \Omega$, so that for a wholesale price $\hat{w}$ that is just marginally larger than 0, the sales constraint (35) is still satisfied. For the moment suppose the sales constraint is satisfied at $\hat{w}$. This reduces the problem to

$$\max_{w_A} \Pi_A = p_A(w_A, 0) \cdot D_A\left(p_A(w_A, 0), p_B(0, w_A)\right) - \Delta$$

and implies a first order condition for $\hat{w}$ of

$$\frac{\partial p_A(w_A, 0)}{\partial w_A} \cdot \left[\frac{\partial D_A(p_A(w_A, 0), p_B(0, w_A))}{\partial p_A} + D_A\left(\cdot\right)\right] + \frac{\partial D_A}{\partial p_B}\frac{\partial p_B}{\partial w_A} p_A\left(\cdot\right) = 0. \tag{36}$$

The condition (36) is not satisfied at $w_A = 0$, as the first term would be zero at $w_A = 0$ whereas the second term, which captures the strategic delegation effect, is strictly positive. Together, this implies that the optimal $\hat{w}$ is positive. If follows from the strategic complementarity of prices (Assumption 6) that the optimal level of w_i increases in w_{-i}, such that a comparison of (36) and (9) implies that $\hat{w} < w^U$ and, in turn, $p^U = p_i(w^U, w^U) > p_i(\hat{w}, 0) > p^{RPM}$.

So far, we supposed that $\pi_i(\hat{w}, 0) > \Omega$ holds. If, on the contrary, the sales constraint (35) binds, then $\hat{w}$ is defined by $\pi_i(\hat{w}, 0) = \Omega$. Recall that $\pi_i(w^*(\Omega), w^*(\Omega)) = \Omega$ and that the retailer profits are decreasing in the symmetric wholesale prices (Assumption 2). Hence, $\hat{w} < w^*(\Omega)$ and, in turn, $p_A(\hat{w}, 0) < p^*\left(\Omega\right) = p_A(w^*(\Omega), w^*(\Omega))$. This results in

$$\min(p^U, p^*\left(\Omega\right)) > p_i(\hat{w}, 0) > p^{RPM}.$$

The same order holds for the deviation profits Π^D in the case of RPM:

$$\min\left(\Pi^*(\Omega), \Pi^U\right) > \Pi^D > \Pi^{RPM}.$$

For the stability of collusion, this implies that the critical discount factor with RPM is lower than without RPM. The reason is that RPM leads to strictly lower profits Π^D and Π^Non the right-hand side of the stability condition (12) than no RPM and to an – at least weakly – larger profit Π^C on the left-hand side. $\square$