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# Manufacturer Collusion and Resale Price Maintenance

Matthias Hunold* and Johannes Muthers†

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**Abstract**

We provide a novel theory of harm for resale price maintenance (RPM). In a model with two manufacturers and two retailers, we show that RPM facilitates manufacturer collusion when retailers have alternatives to selling a manufacturer's product. Because of the alternatives, 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.

**Keywords:** resale price maintenance, collusion, retailing.

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# 1 Introduction

Resale price maintenance (RPM) allows manufacturers to eliminate price competition among retailers and it therefore might lead to higher consumer prices. With the Leegin decision of 2007, the US Supreme Court overturned the long standing per-se illegality of minimum RPM in the US and replaced it with a rule of reason approach.[1] With reference to the economic literature, the court based the decision on the pro-competitive service argument whereby the interests of manufacturers and consumers are broadly aligned with respect to retailer profit margins (Telser, 1960; Marvel and McCafferty, 1984; Mathewson and Winter, 1998, 1984; Winter, 1993). Still, the view that RPM can be anti-competitive remains prevalent among competition policy experts and cases against RPM continue to emerge. For instance, minimum and fixed RPM continue to be core restraints of competition in the European Union's new vertical block exemption regulation of 2022.[2] Against this backdrop, it is surprising that until today the economic literature provides only few formal theories of harm (Asker and Bar-Isaac, 2014; Hunold and Muthers, 2017; Jullien and Rey, 2007). Inspired by recent policy cases against RPM, where these theories do not seem to apply, we contribute a new formal theory of how RPM can facilitate manufacturer collusion.

Resale price maintenance (RPM) has been used by colluding manufacturers of beer, gummi bears, chocolate, and coffee.[3] 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.'[4]

A recent report by an OECD roundtable also describes cases where colluding manufacturers struggled to convince retailers to accept higher wholesale prices without price coordination through RPM.[5] Holler and Rickert (2022) show empirically that

[1] Leegin Creative Leather Products, Inc. v. PSKS, Inc., 551 U.S., 2007.

[2] Minimum and fixed RPM are considered core restrictions of competition in the (EU Vertical Block Exemption, Commission Regulation 2022/720, Article 4a). An efficiency defense according to 101 (3) TFEU is possible in individual cases (par. 197 Vertical Restraints Guidelines of May 2022).

[3] The cases concern Anheuser Busch, Haribo, Ritter, and Melitta; (last access 2023/02/04).

[4] 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 2023/02/04).

[5] '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.

the coffee cartel 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,[6] 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.[7]

The question remains 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. Intuitively, if a product does not yield enough profit to the retailer, the retailer will not stock, or not push and not advise for and advertise the product which can result in dramatically lower sales. Hence, manufacturers need to ensure that the retailers make sufficient profits with their products to have an incentive to sell.

We study the link between RPM and manufacturer collusion in a setting where two manufacturers offer non-linear contracts to two retailers. We consider a repeated game in which manufacturers may use trigger-strategies to collude while retailers are short-lived and thus cannot collude. A key ingredient is that the retailers have outside options, which are valuable alternatives to accepting the manufacturer's contract and selling its product. Similarly, in the static analysis of Hunold and Muthers (2017) the outside option consists of the possibility of a retailer to push products on consumers that are in different markets. One can also interpret the outside options as a degree of bargaining power at the retail level. A motivation for this assumption are, for instance, cases in the food supply chain where retailers have demonstrated a strong

[6]'Roundtable on Hub-and-Spoke Arrangements – Background Note by the Secretariat 3-4 December 2019'; OECD; (last access 2023/02/04).

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

bargaining position, based on their outside options to sell own-branded products, use the shelves for other product categories, and advertise more profitable products more prominently.[8]

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 them under competition.

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 supra-competitive prices are, at least to some degree, 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 without RPM.

We extend the model in various ways to show that the results hold more generally. As one extension, we endogenize the market structure by allowing manufacturers to compete for retailers. Competition for retailers reduces the manufacturer profits under competition but does not affect the retail prices. We show that colluding manufacturers need RPM to increase the retail prices. However, collusion that just stops manufacturers from competing for retailers can be profitable by shifting rents from retailers to manufacturers, even if it does not increase the retail prices.

[8]See section 6 for evidence of buyer power in the aforementioned coffee cartel case. Another illustrative case in point is that 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. Reuters, 2018/04/06, Supermarkets Edeka and Coop expand Nestle boycott (last access 2022/06/24).

As another extension, we allow the manufacturers to unilaterally decide whether to use RPM. Both under competition and collusion, we find that the manufacturers unilaterally adopt RPM if they cannot pre-commit to not use it. In the case of competition, the use of RPM is results in lower manufacturer profits. The reason is that RPM increases price competition by eliminating strategic delegation effects. Thus, if the manufacturers can pre-commit on the non-use of RPM, they prefer to not use RPM under competition. Moreover, we also illustrate how our results can be maintained with multi-product retailers in the form of intrinsic common agents.

Our article is structured as follow. After the related literature in section 2, we set up the model in section 3 and derive the main results in section 4. Section 5 contains the extensions. 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

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.[9]

Other related articles study different vertical aspects of collusion but do not consider RPM. 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. Schinkel et al. (2008) show that when cartel damage claims are limited to direct purchasers of a cartel, the manufacturers may benefit from providing rents to retailers to ensure their cooperation and reduce the risk of detection.

Yet another strand of related literature studies the effects of RPM in settings with manufacturer competition and does not consider collusion (Dobson and Waterson, 2007; Rey and Vergé, 2010).

[9]The main difference between their model and ours is that we allow the retailers to have outside options to accepting the contract and to selling of a manufacturer's product.

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. This relates to the literature on retail services which explains how a monopoly manufacturer can benefit in a static setting from RPM when the retail services exert externalities (Telser, 1960; Mathewson and Winter, 1998) whereas competing manufacturers may also suffer from RPM (Hunold and Muthers, 2017).

Colluding manufacturers may face the same type of problems as a single dominant manufacturer. Retailers may have non-contractible choices that exert externalities on the manufacturer. Asker and Bar-Isaac (2014), Dertwinkel-Kalt and Wey (2022), and Inderst and Shaffer (2019) allow the retailer to buy from an alternative source. Inderst and Shaffer (2019) study how a manufacturer coordinates the supply chain when retailers can buy from a competitive fringe. Similar to the case of colluding manufacturers in our setting, they find that a dominant supplier cannot implement channel profit maximizing prices as the outside option increases the slotting fee and limits the wholesale price. They do not consider additional vertical restraints. Asker and Bar-Isaac (2014) highlight how vertical restraints can be used to foreclose competing manufacturers. For instance, with RPM the incumbent ensures the retailer a certain profit that vanishes once it stocks the product of a competing manufacturer. In a model with a monopoly retailer and linear-contracts, Dertwinkel-Kalt and Wey (2022) focus on the retailer's marginal choices and show that RPM has ambiguous effects on the surplus of consumers and possibly competing brands.

Another problem is that of opportunism. 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. 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 Gieselmann et al. (2021) who focus on fully unobservable contract offers and solve for perfect Bayesian Nash equilibria instead of subgame perfect Nash equilibria.

# 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 as well as vertical types of collusion. The manufacturers live infinitely 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 consisting of a per-unit wholesale price $w_i$ and a fixed transfer $F_i$. 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. We relax the assumption on exclusivity in section 5.1.

**Timing of the stage game and equilibrium.** A key element of our model are the outside options that each retailer has. We differentiate between an alternative to accepting the contract (value of this outside option: $\Delta$) and an alternative to selling the product (value: $\Omega$). With fixed transfers the manufacturers can render the alternatives to contract acceptance unattractive. This is not the case for the alternative at the sales stage.

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 $p_i$.[10]

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 $\Delta$.

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 $\Omega$.

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 (SPNE).[11] By using subgame perfection we abstract from formulating explicit retailer beliefs about the rival's contract offer. The SPNE we identify are strategically equivalent to perfect Bayesian equilibria where retailers correctly anticipate with their beliefs the equilibrium strategy of manufacturers.

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

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

If a retailer does not accept the contract offer, it gets the fixed outside option. If the retailer is the only one who accepted a contract, it receives $(p_i - w_i) \cdot D_i (p_i, \infty) - F_i$, where $D_i (p_i, \infty)$ is the "monopoly" demand for product $i$.

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 do not suffice to incentivize retailers to sell a product. The parameter $\Omega$ encompasses these (opportunity) costs of selling the product after contract acceptance.

[10] 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.

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

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. For example, in Hunold and Muthers (2017) the outside option consists of the possibility of a retailer to push products on consumers that are in different markets. For the retailer the incentive to sell and push a product depends on the profitability of the product. An important insight is that this creates an incentive problem for the manufacturer where the wholesale price not only affects the profitability of the product to the retailer but also the retail price. Thus two goals are traded-off with only one instrument.

To capture this trade-off, a fixed and exogenous outside option is sufficient for the analysis of collusion in the present article. We additionally consider the manufacturers as endogenous outside options to each other in section 5.1. 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".[12] In line with this, one can interpret the outside options as a degree of bargaining power at the retail level.[13]

In addition to the (opportunity) costs of selling the product after contract acceptance ($\Omega$), a retailer might have (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 $\Delta$ 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. This difference also includes the opportunity cost created by contractual clauses that we do not explicitly model, like an obligation of the retailer to advertise. The reverse inequality would mean that the retailer is surprised after contract acceptance by the profit it has to forego in order to sell the product. 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.

[12]Please see section 5 of the discussion paper version Hunold and Muthers (2020) for this extension.
[13]See footnote 8.

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

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

with $\gamma > 0$. A higher value of $\gamma$ 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 condition 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 $\Delta$. 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.

## 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 condition

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

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 condition (6), in equilibrium, it must hold with equality 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 $\Omega$. We analyze in turn the cases of a non-binding and a binding sales constraint.

**Unconstrained marginal wholesale prices.** For $\Omega$ 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 $\Omega$, 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.

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 $\Omega$. 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 $\Omega$ and, in turn, $\Delta$, such that selling would result in a loss for the manufacturers.

**Proposition 1.** *The equilibrium retail prices are not affected by the contract outside option, $\Delta$, but generally depend on the value $\Omega$ of the sales outside option.*

*If $\Omega$ 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 $\Omega$. Manufacturer and industry profits decrease in $\Omega$, whereas retailer profits increase.*

*If the sales outside option value $\Omega$ 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.[14]

The equilibrium fixed transfer is $F^* = \max(\pi_i(w^*, w^*), \Omega) - \Delta$ and can be either negative or positive. Whenever the sales condition (8) binds, $F^* = \Omega - \Delta \leq 0$, resulting in a weakly positive transfer to the retailer. If $\Delta = \Omega$, the optimal tariff is linear.

### 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 $\Delta$) and whether to sell the product (outside option value of $\Omega$).

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. This dampens competition relative to direct price competition between manufacturers at the true and thus lower marginal costs.

The price-reducing effect of RPM is based on the effects identified in Bonanno and Vickers (1988) for the issue of vertical integration versus separation. Note that RPM can have price increasing effects in a static setting (Rey and Vergé, 2010; Hunold and Muthers, 2017). We abstract from these static effects to focus on the collusive effects of RPM.

[14] The result that the retail prices are a function of the outside option to the sale ($\Omega$) but do not depend on the outside option to the contract ($\Delta$) holds more generally than under assumption 1. It also holds for $\Delta < \Omega$, where the fixed transfer would be positive.

## 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 $\Pi^C$ 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 $\Pi^N$ in each future period. In the deviation period, the deviating manufacturer can possibly earn higher profits, which we denote by $\Pi^D$. 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 $\delta$ 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 $\Pi^N$ for the cases without and with RPM. Proposition 2 implies that the competitive profit without RPM is strictly higher 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 ($\Pi^D$) and period profit on the collusive path ($\Pi^C$). In case of punishment, the manufacturers revert to the competitive supply contracts as characterized in Proposition 1, yielding a manufacturer profit of $\Pi^N$.

**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 $\Omega$, binds. A similar case distinction arises under collusion. Let us first focus on the case that $\Omega$ 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 solve:

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

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 $\Omega$ 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 $\Omega$ does not affect the equilibrium, such that a collusive profit $\Pi^C = \Pi^M$ is attainable and is strictly higher than the competitive profit $\Pi^N$. For the stability condition in this case, only the deviation profits $\Pi^D$ 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 $\delta$ 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 collusive equilibrium with a wholesale price of $w^*(\Omega)$ and a retail price $p^*(\Omega)$ if the manufacturers are sufficiently patient.*
- *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.* The collusive prices can be limited by the presence of a sales outside option. 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 loss from not offering both products in the same period.

## 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 $\Pi^C$.** On the collusive equilibrium path the manufacturers solve:

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

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 $\Pi^D$.** 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.[15] 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 solves:

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

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.** *Suppose the manufacturers use RPM and, in addition, coordinate both the wholesale prices and the retail prices. There is a collusive equilibrium with retail prices at $p^M$ and wholesale prices at $w^C$, defined by condition* (21)*, if the man-*

[15]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.

*ufacturers are sufficiently patient. In that equilibrium, each manufacturer makes a profit of $\Pi^M$. 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 $\Omega$: $p^M > p^*(\Omega)$. 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.[16]

**Critical discount factor: Does RPM make collusion more stable?** In case (i), the competitive retail price absent RPM is constrained by $\Omega$, 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 ($\Omega$) 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).

- $\Pi^N$: RPM leads to a lower punishment profit in any case. This effect of RPM stabilizes collusion.
- $\Pi^D$: 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 $\Omega$ 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 $p_B = \arg\max p_B D_B(p_B, p^C)$.
  - 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

[16]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).

deviation profit absent RPM is even lower. This effect of RPM destabilizes collusion.

- $\Pi^C$: In case (iii), there is no relevant ex-post outside option ($\Omega$ 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 $\Pi^M$ with and without RPM. In case (ii), absent RPM the collusive profit is below the profit $\Pi^M$ 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 $\Pi^N$ are lower and the collusive profits $\Pi^C$ are (weakly) higher.*

- *If a non-deviating retailer has to set the collusive price due to RPM, the deviation profit $\Pi^D$ 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 ($\Pi^D$), 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 (discounted) profits for the manufacturer, the manufacturer does not enforce RPM in the sense that the manufacturer accepts the retail price.*[17]

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.[18]

**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.*

[17]Profits refers to the stream of current and discounted future profits. The assumption is relevant in case of a deviation, however, so that the future profits are the same and only the current profits depend on whether RPM is enforced.

[18]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. Hence, the use of minimum RPM can indicate manufacturer collusion.

# 5 Extensions

## 5.1 Endogenous supply chain formation

Consider the case that the manufacturers offer perfect substitutes whereas the retailers are differentiated. This gives rise to particularly strong endogenous outside options for retailers and contrasts our previous assumption of exogenously given supply chains where the manufacturers make take-it-or-leave-it offers and thus have all the bargaining power (up to the outside options of $\Delta$ and $\Omega$). This case is consistent with the demand specification $D_i(p_i, p_{-i})$ introduced in section 3 where it is indistinguishable whether the differentiation is due to products or retailers.

Suppose that each manufacturer can make contract offers to both retailers in stage 1. Thus, each manufacturer provides an alternative to the contract offer of the other manufacturer. As the out-of-market outside options $\Delta$ and $\Omega$ prevail, the endogenous outside option of accepting the contract offer of the other manufacturer in stage 2 "adds to" $\Delta$ but not to $\Omega$, which occurs only at stage 3 after contract acceptance.

Assume that the contracts are exclusive: each retailer can only accept one contract. This assumption rules out that a retailer cashes in on slotting fees with no intention of selling the second product. The literature points out that, with exclusive contracts, manufacturers compete as if they are perfect substitutes even if they are differentiated.

The reason is that the retailer compares the different exclusive contracts in terms of their profitability.[19].

The Bertrand logic applies in our setting with two retailers as well, so that the manufacturers make zero profits in equilibrium as they are perfect substitutes for the retailers. Each manufacturer offers each retailer a contract that maximizes the retailer's profit (utility) by guaranteeing a best-response to the equilibrium contract accepted by the other retailer. We focus on the case that the sales outside option $\Omega$ is large enough, such that under competition without RPM wholesale prices are $w^*(\Omega)$.

This assumption is helpful in avoiding some of the non-existence results that generally plague models with this market structure.[20] The resulting competitive equilibria yield the same prices as in section 4. The difference is that, due to competition in contracts, the rents are fully shifted to the retailers. While endogenously different market structures could emerge, it turns out that it is an equilibrium that each manufacturer contracts with its retailer, as we previously assumed in section 4. Of course, there are equivalent equilibria where manufacturer $A$ contracts with retailer $B$ and vice versa.

In collusive periods, it is optimal for the manufacturers that each manufacturer only makes an offer to its retailer. Thereby, manufacturers avoid competition in contracts and the endogenous outside option vanishes, such that the manufacturers are able to extract profits from the retailers up to the exogenous outside options. Without RPM the outside option needs to be satisfied through the sufficiently low wholesale price $w^*(\Omega)$, which implies that prices are the same as under competition. With RPM, the manufacturers can implement monopoly prices. In summary, collusive periods are unaffected by the endogenous supplier choice. However, when a manufacturer deviates from collusion, it optimally offers contracts to both retailers and thereby pushes the non-deviating manufacturer out of the market. This increases the deviation profits and thereby makes collusion less stable.

The major difference to the case of an exogenous market structure is that collusion, even without RPM, yields a rent shift towards manufacturers, compared to zero profits under competition. Thus RPM is not necessary for collusion to be profitable even if collusion does not allow the manufacturers to increase the retail prices above the competitive level.

We summarize the results in

**Proposition 7.** *Suppose that each manufacturer can offer both retailers exclusive contracts and $\Omega$ is sufficiently large, such that $p^U > p^*(\Omega)$:*

*Under manufacturer competition without RPM, there exists an equilibrium with*

[19]Exclusive contracts can also arise endogenously even though they may be less profitable to manufacturers (Calzolari and Denicolò, 2013).

[20]See Schutz (2013) and the remark below Proposition 7 for a discussion of non-existence of pure strategy equilibria.

*retail prices of* $p^*(\Omega)$ *and wholesale prices of* $w^*(\Omega)$ *where each manufacturer deals with one retailer. The manufacturers make zero profits.*

*Under manufacturer competition with RPM, the retail prices equal* $p^{RPM}$ *in any pure strategy equilibrium and the manufacturers make zero profits. Pure strategy equilibria exist if* $\Omega$ *is sufficiently large to satisfy condition* (39) *(in the proof).*

*Under manufacturer collusion without RPM, there is an equilibrium with retail prices of* $p^*(\Omega)$ *and wholesale prices of* $w^*(\Omega)$*. For discount rates of* $\delta < 1/2$*, the manufacturer profits are zero. For* $\delta \geq 1/2$*, each manufacturer deals with one retailer and realizes industry profits minus* $\Delta$ *at the price level* $p^*(\Omega)$*.*

*Under manufacturer collusion with RPM, if* $\delta \geq 1/2$*, on the equilibrium path each manufacturer deals with one retailer and prices are at the monopoly level* $p^M$*.*

*Proof.* See annex. □

When each manufacturer is a relevant alternative to the other manufacturer, this leads to competitive pressure for the manufacturers and shifts rents to the retailers. The manufacturers can prevent this competition in contracts by colluding to not offer contracts to the same retailer. This alone can be profitable. However, depending on the strength of the sales outside option, prices and industry profits may not go up at all, or at least not to the monopoly level. Therefore, using RPM has the potential for the colluding manufacturers to (further) increase their profits.

**Remark on the existence of competitive equilibria.** We know from Schutz (2013) that, for public contract offers, under competition no pure strategy equilibrium exists. However, our model differs as the contracts are only interim observable and the outside option limits the wholesale price: a possible deviation of manufacturer $A$ is to offer a larger wholesale price $w' > w^*$ and a lower fixed transfer $F' < F^*$ to retailer $B$. Such a deviation is typically profitable with observable offers and destroys the equilibrium as retailer $B$ does then not accept manufacturer $B's$ contract offer. However, with this contract offer the retailer does not sell because any increase in $w$ violates the sales condition that was already binding. There is thus no profitable deviation as only contracts that have weakly lower wholesale prices yield positive sales. Such contracts, however, imply a reduction in industry profits due to the lower resulting retail price level. As the retailers obtain all industry profits, there is no scope for deviating contract offers that increase the retailer profit and would be acceptable. Interim observability rules out that the content of manufacturers' contracts with retailer $B$ affects the contract acceptance of retailer $A$.

In the case of competition with RPM, pure strategy equilibria may not exist for all parameters but we demonstrate their existence for the case that the outside option $\Omega$ is sufficiently large. With RPM different deviations are possible as the deviating manufacturer can increase the industry profits by setting higher retail prices. However, this is not necessarily profitable as a retailer does not observe the price increase at the other retailer when accepting the contract, due to interim observability. Thus the retailers only accept lower fixed transfers and the deviation can only become profitable if the manufacturer can extract enough of the additional industry profits through the linear wholesale prices.

## 5.2 Endogenous resale price maintenance

In section 4 we assume that either both manufacturers use RPM or both manufacturers do not use RPM. For the case that RPM is enforceable, we now make the use of RPM voluntary for each manufacturer.

When RPM is enforceable, each manufacturer decides privately whether to include RPM in its contract offer. In stage 4, the revelation of the contracts makes the use of RPM common knowledge. This is a natural extensions of our model as we assume that contracts are private at the stage when retailers decide on their acceptance.

We find that, when RPM is chosen endogenously, there are equilibria in which it is adopted for each case (collusive periods, deviation periods, competitive periods). Thus, the results are similar to the exogenous RPM regime of section 4. A difference occurs in the case of competition with RPM as an equilibrium can exist where no manufacturer chooses RPM if the sales condition (2) does not bind.

Let us first demonstrate that, when manufacturers compete, it is a (weakly) dominant strategy for each manufacturer to use RPM, so that RPM emerges in equilibrium. If manufacturer $B$ uses RPM, the retail price of product $B$ is unaffected by the contract offer of manufacturer $A$. Hence, it is a best-response for manufacturer $A$ to implement the price that maximizes channel profits via RPM.

If manufacturer $B$ does not use RPM, manufacturer $A$ can soften the response of retailer $B$ by either including a larger wholesale price (without RPM) or setting a larger retail price (with RPM). As both choices are observed by retailer $B$ before pricing and retailer $B$ only cares about the expected price of retailer $A$, these choices are equivalent. However, manufacturer A cannot implement every price without RPM as the sales outside option ($\Omega$) may limit the wholesale price. Thus, manufacturer $A$ either strictly prefers to use RPM or is indifferent between using and not using it.[21] Thus, there exists a symmetric SPNE of the stage game in which both manufacturers use RPM. The market outcome is the same as in the case of competition with RPM in section 4.3.

Consider the case that manufacturers collude. On the equilibrium path with RPM, both manufacturers obtain half of the maximal industry profit net of retailers' outside

[21] If the sales outside option binds under competition without RPM, the equilibrium that both manufacturers use RPM is unique and in dominant strategies.

options. This outcome can be supported by trigger strategies, provided that the manufacturers are patient enough. Let us now argue that the previous stability condition (25) is maintained as the deviation profits are the same. When a manufacturer wants to deviate from a collusive path that involves RPM, the manufacturer can do this by making its retailer a deviating offer in stage 1. As the non-deviating manufacturer still uses RPM in the deviation period to implement the monopoly price, there is no advantage of not using RPM for the deviating manufacturer because strategic delegation does not play a role. The deviation with RPM as described in section 4.6 is thus also an optimal deviation in the present case with endogenous RPM.

In summary, when the manufacturers unilaterally choose in each period whether to use RPM, equilibria with the same collusive and competitive market outcomes exist as in section 4 when assuming that the manufacturers have to use RPM when it is enforceable.

**Alternative assumption: Pre-commitment on RPM.** For the case where RPM is enforceable, one could alternatively assume that each manufacturer can commit itself at the beginning of each period, that means in an additional stage 0 before the manufacturers make contract offers, whether to use RPM or not. This would immediately become common knowledge.

Intuitively, competing manufacturers can benefit from committing to not use RPM. The reason is that equilibria with RPM yield lower profits as they rule out the competition dampening strategic delegation effects (see Proposition 2). Consider the candidate equilibrium where manufacturers $A$ and $B$ use RPM and implement $p^{RPM}$. Suppose manufacturer $A$ deviates and commits to *not* use RPM in stage 0. Manufacturer $B$ observes this before offering a contract in stage 1 and realizes that, by increasing $p_B$, it can increase the price that retailer $A$ sets. This is because retailer $A$, who is no more bound by RPM, observes all contracts in stage 4 before choosing its price. Thus, by committing not to use RPM, manufacturer $A$ provides incentives for $B$ to increase the price $p_B$. By subgame perfection, retailer $A$ understands that not being bound by RPM results in higher profits, which manufacturer A can therefore extract through the fixed transfer $F_A$. This makes it strictly profitable for manufacturer A to not use RPM and thereby eliminates the competitive candidate equilibrium with RPM. [22]

When the manufacturers collude, there is no difference on the equilibrium path to the results derived above and, consequently, those of section 4. If a manufacturer wants to deviate from a collusive path that involves RPM, a profitable deviation is only feasible if the manufacturer commits to using RPM also in the deviation period. If the manufacturer were to commit to not using RPM in stage 0, the other manu-

[22] Note that we prove in Proposition 2 that, starting from the price under RPM, there is always scope for marginal price increases without violating the sales condition.

facturer would know about the deviation already when making a contract offer to its retailer in stage 1, resulting immediately in a competitive outcome. In punishment periods, the manufacturers play the competitive stage game equilibrium in which both manufacturers do not use RPM.

In summary, when the manufacturers can pre-commit on the (non) use of RPM in each period, there is an equilibrium of the repeated game where the play in collusive periods and deviation periods is identical to the one we derived before in section 4 under the assumption that RPM is used. However, in the case with pre-commitment, the competitive periods, and thus the punishment periods, feature a symmetric equilibrium without RPM. As before, RPM still enables the manufacturers to achieve higher collusive profits but the collusive equilibrium may exist only for higher discount factors than with exogenous RPM and no pre-commitment on RPM as characterized in section 4.

### 5.3 Multi-product retailers

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 where the results we obtained with 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 (2020), feature more detailed negotiations between manufacturers and retailers and a more involved information structure.[23] However, in this extension we focus 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. There is generally horizontal differentiation now both at the manufacturer and at the retail level. The demand for product $i$ at retailer $j$ is thus 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

[23]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.

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

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 at a price level of $p$ 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) is below the industry profit maximizing price ($p^M$) 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 $\Omega$ 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 $\Omega$ 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 $\Omega$ 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.[24] 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 that our 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 (2022) 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.[25] 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 (2022) 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 overcharge, 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.

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

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

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).[26] 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).[27]

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.

**Buyer power.** The court decisions confirm that the food retailers have buyer power in general and in particular also vis-a-vis the coffee roasters.[28] The buyer power is said to have increased in the years before the cartel by the introduction of private labels and an increased market concentration at the retail level. This supports the assumption of relevant outside options of the retailers to accepting the contract of a manufacturer in our model.

# 7 Conclusion

We started from the empirical observation that resale price maintenance (RPM) has been used by colluding manufacturers in various competition policy cases and appeared to be an important factor in making collusion successful. Studying these cases, we

[26]OLG Düsseldorf, court decision V-4 Kart 5/11 (OWi) of February 10, 2014.
[27]OLG Düsseldorf (2004), see fn. 26 above.
[28]See, for instance, recital 73 in the reference of fn. 24.

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 policy, our insights are relevant as they allow to rationalize the use of RPM by colluding manufacturers in actual cases, as 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 extend to settings where the retail market structure is endogenous, where the manufacturers unilaterally choose whether to use RPM, and where there are 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 a value alternative to the contract and another valuable alternative to selling the product, that is still relevant after contract acceptance. Whereas the fixed fees suffice to ensure contract acceptance, sufficiently high retail margins are necessary to provide the incentive to sell the product.

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 from various fundamental problems regarding the coordination of competing downstream firms that also an upstream monopolist suffers from. 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 $\Delta$, the value of rejecting 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 $\Delta$ 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

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

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

The critical discount factor $\hat{\delta}^{Case\,(ii)}_{NoRPM}(\gamma, \Omega)$ 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 $\Omega$. In particular, $p^*(\Omega) > p^U$ implies an upper bound of $\Omega$ 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 $\hat{\delta}_{RPM}(\gamma) > \hat{\delta}^{Case\,(ii)}_{NoRPM}(\gamma, \Omega)$ 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

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

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, $p_A(\hat{w}, 0) < p^*(\Omega) = p_A(w^*(\Omega), w^*(\Omega))$. This results in

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

The same order holds for the deviation profits $\Pi^D$ 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 $\Pi^D$ and $\Pi^N$on the right-hand side of the stability condition (12) than no RPM and to an – at least weakly – larger profit $\Pi^C$ on the left-hand side. □

*Proof of Proposition 7.* Consider the case of manufacturer competition without RPM. The candidate equilibrium is that each manufacturer deals only with its retailer, resulting in symmetric equilibrium contracts $(F^*, w^*)$ with $w^* = w^*(\Omega)$. Let us verify that this is indeed an equilibrium.

Retailer $A$ accepts the contract of manufacturer $A$ if retailer $A$ makes larger profits than under the two alternatives

- of selling no product, yielding $\Delta$;
- selling product $B$, such that the contract acceptance condition becomes $\pi_A(w_A, w^*) - F_A \geq \max(\pi_A(w_B, w^*) - F_B^*, \Delta)$.

In any equilibrium with contract acceptance, condition $\pi_A(w^*, w^*) - F^* \geq \Delta$ holds, such that

$$\pi_A(w_A, w^*) - F_A \geq \pi_A(w^*, w^*) - F^*. \tag{37}$$

By the usual Bertrand logic, if both manufacturers offer contracts, each will reduce the fixed fee until it makes a profit of zero from the contract. This implies

$$w^* \cdot D_i(p_i^*(w^*, w^*), p_{-i}^*) + F^* = 0 \tag{38}$$

in equilibrium. Conditions (37) and (38) together imply

$$F^* = w^* \cdot D_i(p_i^*(w^*, w^*), p_{-i}^*)$$

and yield a retailer profit (including fixed transfers) of

$$p^* D_i(p^*, p^*).$$

The Bertrand logic also implies that, in the symmetric equilibrium, each manufacturer chooses $w_i$ to maximize its retailer's profit with its product. This results in $w^*(\Omega)$ due to the binding sales condition.

Under competition with RPM, in any pure strategy equilibrium, the Bertrand logic still applies, such that the manufacturers make zero profits in any equilibrium and offer contracts that are best responses to the contract accepted by the other retailer. This logic implies that, in equilibrium, the retail price must equal $p^{RPM}$ as this price is the unique mutual best response. There is a degree of freedom in the choice of $w$ and $F$, provided that they yield zero manufacturer profits if the contract is accepted. A simple solution is $w = F = 0$. Suppose manufacturer $B$ offers such contracts. In equilibrium, it must be that it is optimal for manufacturer $A$ to do the same.

A pure strategy equilibrium exists if no manufacturer wants to deviate from it. There are a number of possible deviations. Any profitable deviation must entail that the deviating manufacturer becomes the only supplier of both retailers in the deviation period. If both suppliers are active, because the equilibrium contract is already a best response to the equilibrium contract as it maximizes the bilateral profits, there can be no strictly better contract that the manufacturer can offer.

The deviating manufacturer must thus become the only supplier and therefore ensures that each retailer, when accepting its contract, makes the same profit as in the candidate equilibrium: $p^{RPM}D(p^{RPM}, p^{RPM}) - \Delta$. Suppose manufacturer $A$ deviates by offering a contract $(p_i', w_i', F_i')$ to each retailer $i \in \{A, B\}$. Retailer $i$ does neither know nor anticipate a different retail price of its competitor in case of such a deviation and accepts the contract if

$$(p_i' - w_i')D_i(p_i', p^{RPM}) - F_i' - \Delta \geq p^{RPM}D_i(p^{RPM}, p^{RPM}) - \Delta.$$

Hence, a deviating manufacturer can maximally set

$$F_i' = (p_i' - w_i')D_i(p_i', p^{RPM}) - p^{RPM}D_i(p^{RPM}, p^{RPM}).$$

Thus the deviating manufacturers profit with each retailer is

$$w_i'D_i(p_i', p_{-i}') + (p_i' - w_i')D(p_i', p^{RPM}) - p^{RPM}D_i(p^{RPM}, p^{RPM}).$$

Note that the first $D_i$ in the previous line is the true demand, depending on the actual retail prices, whereas the second $D_i$ is the demand the retailer anticipates in this off-equilibrium situation. A deviation is profitable for the manufacturer if

$$\sum_i w_i'D_i(p_i', p_{-i}') + (p_i' - w_i')D_i(p_i', p^{RPM}) - p^{RPM}D_i(p^{RPM}, p^{RPM}) > 0,$$

which is equivalent to

$$\underbrace{\sum_i w_i' \left[D_i(p_i', p_{-i}') - D_i(p_i', p^{RPM})\right]}_{X} + \underbrace{p_i'D_i(p_i', p^{RPM}) - p^{RPM}D_i(p^{RPM}, p^{RPM})}_{Y} > 0. \tag{39}$$

First, note that $Y < 0$ follows from the bilateral optimality of $p^{RPM}$. Hence, for a profitable deviation it is necessary that $X > 0$ and, moreover, $X > |Y| > 0$. However, even if $D_i(p_i', p_{-i}') - D_i(p_i', p^{RPM}) > 0$, such that $X > 0$, the term $X$ converges to zero as the sales outside option value $\Omega$ increases.

Note that $w_i'$ is limited by the retailers' willingness to sell the product, which in the deviation case is given by

$$(p_i' - w_i')\, D(p_i', p^{RPM}) \geq \Omega \forall i.$$

This limits $w_i'$ the more the larger $\Omega$. Hence, if $\Omega$ is sufficiently large, 39 is violated, such that there is no profitable deviation.

In contrast, if (39) holds for some combination of $p_A'$,$p_B'$ and $w_A', w_B'$, then no pure strategy equilibrium exists.Under manufacturer collusion without RPM, the industry profits cannot increase as there is no larger $w$ that yields positive sales. The manufacturers collude by offering only a contract to the own retailer. This shifts rents to the manufacturers. Is there an incentive to deviate? On the equilibrium path each manufacturer makes strictly positive profits. Suppose manufacturer $B$ deviates. It can offer retailer $A$ a lower fixed fee but cannot increase $w$. This results essentially in double the sales and double the profits and is the optimal deviation. Under punishment they are back to the competitive equilibrium with zero profits. The critical discount factor equals 1/2 as the stability condition is

$$\frac{\Pi^C}{1-\delta} \geq 2\Pi^C + \frac{\delta \cdot 0}{1-\delta} \Leftrightarrow \delta \geq 1/2. \tag{40}$$

When the manufacturers collude using RPM, in a collusive period each manufacturer makes a profit equal to half the monopoly profit minus the retailer's outside option $\Delta$. The deviation profits are approximately twice as high as the collusive period profits because a deviating manufacturer can induce both retailers to accept its contracts by offering the other retailer a marginally more profitable contract than the other manufacturer's collusive offer. The punishment profits are zero as argued above. Hence, the stability condition is equivalent to condition (40), yielding a critical discount factor of 1/2. □

# Annex B: Within-market alternatives (store brands)

Before, we assumed that each retailer has exogenous outside options with values $\Delta$ and $\Omega$ that materialize when the retailer does not accept the contract or sell the product. We now consider the case in which the alternative consists of selling a (perfect) substitute to the manufacturer's product within the market even after accepting the manufacturer's contract. We analyze this setting first with linear and then with two-part tariffs.

Assume that each retailer can acquire a store brand produced by a competitive fringe that is identical to its manufacturer's product. This product is produced and sold at constant marginal costs of $c \geq 0$ to the retailer. The store brands of the different retailers are still differentiated just like the brand products of the manufacturers A and B.

**Assumption 7.** *The store brand production is sufficiently efficient ($c$ low enough), such that, without the fringe products and under manufacturer competition with linear tariffs, each manufacturer would unilaterally charge a larger wholesale price than $c$ if the other manufacturer charges a wholesale price of $c$.*

Let us first consider linear tariffs and then two-part tariffs. The timing is:

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 $p_i$.

2. Each retailer $i$ observes its contract offer, rejects the offer of manufacturer $i$ or accepts it;

3. Each retailer decides whether to purchase the store brand from the competitive fringe and sell it;

4. Each retailer observes whether a store brand is offered in the market;

5. Simultaneously:

    - Each retailer who observes a store brand at the other retailer and who has previously accepted the manufacturer's contract can offer his manufacturer a different contract ($w_i$ and an RPM price in the case of RPM); the manufacturer accepts or declines the retailer's offer; in the case of rejection, the previous contract is in force.
    - Each retailer sets the retail price $p_i$ (possibly bound by RPM).[29]

6. Consumers choose whether and where to buy.

In stage 5 we allow retailers to react to the presence of store brands. Without renegotiation, the store brand would allow each retailer a 'free-ride' on RPM that still binds the other retailer. Although, in this case, enforcing RPM is in the interest of neither the retailer nor its supplier. Alternatively to a full renegotiation of the contract, one could assume that manufacturers do not enforce RPM in case store brands are offered, which yields qualitatively similar results.

## Linear tariffs

**Manufacturer competition without RPM.** If the outside option is sufficiently attractive, $c$ is below the unconstrained wholesale price, then $w_i$ is limited by $c$. This is the case due to assumption 7.

In equilibrium, each manufacturer offers $w_i = c$ and the resulting consumer prices are $p^*(c, c)$. No manufacturer can set a larger wholesale price and expect the retailer to sell any quantity of its product. Moreover, no manufacturer has an incentive to lower its wholesale price as this results in lower profits. In summary, the result is comparable to the case of a fixed outside option.

[29] As for each retailer $i$ the fringe product and the product of manufacturer $i$ are perfect substitutes, there is only one retail price at the retailer

**Lemma 2.** *With wholesale prices of $c$, no retailer has an incentive to purchase the perfect substitute from the competitive fringe in stage 3. If a retailer were to stock the fringe product, the renegotiation that would become possible at the other manufacturer-retailer pair would not lead to a different wholesale price. With linear contracts, there is no scope for renegotiating $w_i = c$ when the competitor has costs of $c$, as the manufacturer prefers increasing the wholesale price while the retailer wants to reduce the price. In equilibrium, $w_i = c\ \forall i$ as if renegotiation were not possible (absent stage 5).*

**Cartel without RPM.** Given negative price externalities, a manufacturer cartel that maximizes the joint manufacturer profits would find it profitable to increase prices above the competitive level if there was no fringe competition. However, similar to the previous case of manufacturer competition, the manufacturer cartel is limited by the fringe cost of $c$, which again results in $w_i = c$ and $p^*(c, c)$. If the cartel charged a price above $c$ both retailers would rather sell their store brand. This occurs whenever the competing manufacturers are limited by $c$ as well (Assumption 7). Again, the possibility to renegotiate has no impact as there is no scope to reduce the wholesale price below $c$, such that, when selling, both retailers facing costs of c is the relevant outside option.

The cartel could increase its profits compared to competition only if the outside option was not sufficiently attractive to affect the competitive equilibrium, that is, when $w^* < c$. This case is excluded under Assumption 7.

**Proposition 8.** *The same prices and profits as absent a cartel and absent RPM result.*

**Cartel with RPM.** With linear tariffs, the cartel could make larger profits with RPM if and only if it can increase the wholesale price above $c$. So when does a retailer accept a contract with a larger wholesale price?

With RPM, we characterize an equilibrium in which each manufacturer offers a contract with a price fixed at the industry profit maximum $p^C$ and an accompanying wholesale price $w^C > c$ in stage 1. Both retailers accept the symmetric offers and do not purchase from the fringe.

To establish that this is an equilibrium, we have to rule out that a retailer, say $-i$, purchases the perfect substitute from the fringe in stage 3 at a lower wholesale price of $c$ and is free to choose its retail price. The downside of buying from the fringe is that the other retailer can react to this unexpected market behavior by renegotiating its contract with the manufacturer.

If retailer $-i$ decided to sell a store brand, the downstream prices and profits depend on how retailer $i$ reacts to this deviation in stage 5a. Retailer $i$ makes manufacturer $i$ an offer with a retail price that best-responds to the marginal costs of $c$ that retailer $-i$ has based on the marginal production cost of 0 for product $i$. The wholesale price is set in a way that manufacturer $i$ accepts the offer. This yields a deviation profit of the retailer $-i$ when stocking the fringe product of $\pi(c,0)$. The deviation profit of a retailer is given by the profit a retailer makes when having marginal costs of $c$ and competing in prices against a competitor with marginal costs of 0.

Let us now find the optimal contracts of the colluding manufacturers in stage 1. Suppose each manufacturer offers a contract with a price fixed at the industry profit maximum $p^C$ and an accompanying wholesale price $w^C > c$. The resulting profit of each retailer has to be larger than the one obtained from selling the store brand. As the deviation profits are $\pi(0,c)$ independent of the equilibrium contract, the manufacturers will optimally choose the monopoly retail price of $p^C$ and set the wholesale price $w$ to satisfy

$$(p^C - w) \cdot D(p^C, p^C) = \pi(c, 0).$$

Note that $\pi(c,0)$ is smaller than the profit $\pi(c,c)$ which a retailer makes when the competitor has marginal costs of $c$ as well. This is the equilibrium profit absent RPM (see above). Moreover, $(p^C - c) \cdot D(p^C, p^C) > \pi(c,c)$ as the latter results under retailer competition. This implies that $w > c$ is feasible with RPM for the colluding manufacturers. Moreover, as the industry profits are higher with retail prices of $p^C$ than without RPM and the retailers make lower profits, the colluding manufacturers make higher profits and thus benefit from RPM.

*Summary.* The manufacturer cartel achieves monopoly prices with RPM and benefits from RPM and collusion, whereas the retailers are worse off than in the cases absent RPM.

**Competition with RPM.** As in the previous case with RPM, a retailer's deviation profit when sourcing from the fringe is again independent of the initial contracts as the renegotiated prices are best-responses to the fringe costs and given by $\pi(c,0)$.

If manufacturers compete using RPM, they will set retail prices that maximize the joint surplus of a manufacturer and its retailer net of the retailer's outside option. This means that the retail price is set based on the true costs of 0. The resulting retail prices on the equilibrium path are thus based on the true marginal costs of 0 as well. The industry profit per product thus equals $\pi(0,0)$ and is lower than the industry profit absent RPM as long as the retail price level at fringe costs ($p^*(c)$) is below the monopoly level (we assume this).

Each manufacturer sets the wholesale price to satisfy the retailer's participation constraint with equality:

$$(p^*(0) - w) \cdot D(p^*(0), p^*(0)) = \pi(c, 0).$$

| Setting (below) | Industry profits (per product) | Retail profits | Manufacturer profit |
|---|---|---|---|
| No RPM (either competition or collusion) | $\pi(c,c) + c \cdot D_i(p^*(c), p^*(c))$ | $\pi(c,c)$ | $c \cdot D_i(p^*(c), p^*(c))$ $= p^*(c)D_i(c,c) - \pi(c,c)$ |
| RPM and competition | $\pi(0,0)$ | $\pi(c,0)$ | $\pi(0,0) - \pi(c,0)$ $= p(0,0) \cdot D_i(0,0) - \pi(c,0)$ |
| RPM and collusion | $p^C \cdot D_i(p^C, p^C)$ | $\pi(c,0)$ | $p^C \cdot D_i(p^C, p^C) - \pi(c,0)$ |

Table 3: Summary of prices and profits for the case of linear tariffs

Again, the retailers make lower profits than absent RPM where the profit is $\pi(c,c)$. Whether the competing manufacturers make less profit with RPM than without depends on whether the reduction in industry profits dominates the reduction in retail profits.

*Summary.* When manufacturers compete, the introduction of RPM leads to lower retail prices (as absent renegotiations).

**Summary of the linear tariff case when the retailers can sell a perfect substitute.** Without RPM, the market outcome is again identical in the cases of manufacturer competition and an optimally organized manufacturer cartel. Hence, there is no scope for a cartel without RPM. The use of RPM does not affect the equilibrium profits of competing manufacturers. However, colluding manufacturers can use RPM to increase the wholesale price and retail prices if the RPM is sufficiently flexible, such that an industry-wide RPM collapses or is adapted when the retailers deviate by introducing store brands. This makes the introduction of store brands less attractive.

## Solution for the case of two-part tariffs

Suppose that the game is as above, with the exception that the manufacturers use observable two-part tariffs that include a fixed transfer $f_i$ from retailer $i$ to manufacturer $i$ in the contract. The fixed transfer takes place upon contract acceptance in stage 2.

We exclude below marginal cost pricing, which implies $w \geq 0$.

**Manufacturer competition without RPM.** If retailer $-i$ rejects the offer of the manufacturer and buys from the fringe, retailer $i$ can make a new offer to manufacturer $i$. This offer is independent of the equilibrium tariff and equals $\pi(c, 0)$.[30]

Each manufacturer faces the following problem:

$$\max_{w_i, F_i} \Pi_i = f_i + w_i \cdot D_i(p_i, p_{-i})$$
$$s.t. \text{ retailer ex-ante participation:} (p_i - w_i)D_i(p_i, p_{-i}) - f_i \geq \pi(c, 0),$$
$$\text{retailer ex-post incentive constraint:} (p_i - w_i)D_i(p_i, p_{-i}) \geq \pi(c, 0).$$

In equilibrium, at least the ex-ante participation constraint has to bind as otherwise manufacturer $i$ could increase $f_i$ until it binds. Given the ex-ante constraint binds, the ex-post constraint can only hold if $f_i$ is non-negative. This yields

**Lemma 3.** *The fixed fees cannot be negative in equilibrium.*

The problem can be rewritten as, with $f_i \geq 0$, the ex-post constraint always holds when the ex-ante constraint is fulfilled:

$$\max_{w_i, F_i} \Pi_i = f_i + w_i \cdot D_i(p_i, p_{-i})$$
$$s.t. (p_i - w_i)D_i(p_i, p_{-i}) - f_i = \pi(c, 0),$$
$$f_i \geq 0.$$

Solving for $f_i$ and substituting into the objective function yields

$$\max_{w_i} \Pi_i = p_i^* \cdot D_i(p_i^*, p_{-i}^*) - \pi(c, 0) \tag{41}$$
$$s.t. f_i = (p_i^* - w_i)D_i(p_i^*, p_{-i}^*) - \pi(c, 0),$$
$$f_i \geq 0.$$

Each manufacturer effectively maximizes the joint manufacturer and retailer profits with its product. Strategic delegation plays a role with observable wholesale tariffs, that is, an increase in a manufacturer's wholesale price increases the retail price of the competing manufacturer's product. Thus, the marginal wholesale prices are positive in equilibrium: $w^* > 0$. Note that the deviation profit $\pi(c, 0)$ only affects the fixed transfer $f_i$.

[30] Note that in stage 5 the renegotiation and downstream price setting are simultaneous.

The equilibrium price level thus corresponds to the competitive outcome of direct price competition between manufacturers, dampened by the effects of strategic delegation as in Bonanno and Vickers (1988).

**Cartel without RPM.** The manufacturers could now coordinate on charging the highest possible marginal wholesale prices. These are achieved at the lowest possible fixed fees of $f_i = 0$, which implies that the retailer's participation constraint becomes $\pi(w, w) - \pi(c, 0) = 0$. Note that marginal wholesale prices above $c$ are – in principle – feasible because at $w^* = c$, we get $\pi(c, c) - \pi(c, 0) > 0$, leaving scope to increase $w$. Depending on the wholesale price level under competition, the cartel may thus be able to raise the price level – to some extent.

**Cartel with RPM.** Suppose each manufacturer offers a contract with a price fixed at the industry profit maximum ($p^C$) and a wholesale price $\tilde{w}$.

The cartel's maximization problem is

$$\max_{p_i w_i, F_i} \sum \Pi_i = \sum_i f_i + w_i \cdot D_i(p_i, p_{-i})$$
$$\text{s.t.}(p_i - w_i)D_i(p_i, p_{-i}) - f_i \geq \pi(c, 0),$$
$$f_i \geq 0.$$

The renegotiation if one retailer purchases from the fringe is as before and implies a profit of $\pi(c, 0)$ for the deviator. The deviation profit is as before because if retailer $-i$ deviates and buys from the fringe, retailer $i$ will make an offer to manufacturer $i$. The retail price will be a joint best-response of the manufacturer(s) and retailer $i$ against retailer $-i$ with its fringe supply.

The cartel has sufficient instruments to maximize the industry profit and ensure that each retailer gets a profit equal to the outside option of $\pi(c, 0) \geq 0$. Given $p_i = p^C$, the retailer's contract acceptance condition becomes

$$(p^C - w_i)D_i(p^C, p^C) - f_i \geq \pi(c, 0).$$

Different feasible combinations of $w_i$ and $f_i$ fulfill this condition with equality; for instance, $w_i = 0$ and $f_i = p^C D_i(p^C, p^C) - \pi(c, 0) > 0$. We summarize in

**Lemma 4.** *With RPM, colluding manufacturers implement the industry profit maximum and extract all profits from the retailers up to the outside option* $\pi(c, 0)$.

**Competition with RPM.** Each manufacturer's problem is to

$$\max_{w_i, F_i, p_i} \Pi_i = f_i + w_i \cdot D_i(p_i, p_{-i})$$
$$\text{s.t.} (p_i - w_i) D_i(p_i, p_{-i}) - f_i \geq \pi(c, 0),$$
$$f_i \geq 0.$$

The outside option profit that results when rejecting the contract and purchasing the fringe good is still $\pi(c, 0)$ as this triggers a renegotiation of the other retailer and manufacturer.

Suppose that manufacturer $-i$ sets the retail price equal to the candidate equilibrium price $p^*$. Manufacturer $i$ will set a retail price that is an unconstrained best-response which maximizes the joint profits of manufacturer $i$ and retailer $i$. This is the case because, with RPM, the manufacturer has enough instruments to satisfy the participation constraint of the retailer with equality while $f_i \geq 0$. For instance, the prices $w_i = 0$ and $f_i = p^* D_i(p^*, p^*) - \pi(c, 0)$ achieve this. In this case, the fixed fee is strictly positive as $p^* D_i(p^*, p^*) = \pi(0, 0)$, which yields $f_i = \pi(0, 0) - \pi(c, 0) > 0$.

As a result, the retail prices equal the prices that would result under direct price competition between the manufacturers. Note that there are no dampening effects of strategic delegation as the pricing is not delegated to the retailers. Thus, the prices are below those under manufacturer competition without RPM.

**Summary.** Compared to linear tariffs, two-part tariffs can increase the manufacturer profits in the cases without RPM as the renegotiations are more aggressive to the detriment of the retailer that purchases the fringe product. Moreover, collusion may also raise the prices to some degree even without RPM. Nevertheless, RPM still facilitates collusion by further increasing the prices up to the monopoly level.

The market outcome is identical between an optimally organized cartel and competition when there is no RPM. Hence, there is no scope for a cartel without RPM. With RPM and competition, profits cannot be larger. The cartel with RPM can increase prices and wholesale prices if the RPM is sufficiently flexible such that industry-wide RPM collapses or is adapted in case store brands are introduced. This makes the introduction of store brands less attractive.

| Setting (below) | Industry profits (per product) | Retail profits | Manufacturer profit |
|---|---|---|---|
| No RPM (either competition or collusion) | $\pi(c,c) + c \cdot D_i(p^*(c), p^*(c))$ | $\pi(c,0)$ | $c \cdot D_i(p^*(c), p^*(c))$ $= p^*(c)D_i(c,c) - \pi(c,c)$ |
| RPM and competition | $\pi(0,0)$ | $\pi(c,0)$ | $\pi(0,0) - \pi(c,0)$ $= p(0,0) \cdot D_i(0,0) - \pi(c,0)$ |
| RPM and collusion | $p^C \cdot D_i(p^C, p^C)$ | $\pi(c,0)$ | $p^C \cdot D_i(p^C, p^C) - \pi(c,0)$ |

Table 4: Summary of prices and profits for the case of two-part tariffs