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Resale Price Maintenance: Hurting Competitors, Consumers and Yourself

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Resale Price Maintenance: Hurting Competitors, Consumers and Yourself

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Abstract

Improving retailers' incentives for service is a prominent efficiency defense for resale price maintenance (RPM). We investigate the incentives of symmetric manufacturers to use RPM when selling products through common retailers who provide services such as pre-sale advice. We show that the possibility to use minimum RPM can create a dilemma for manufacturers when retailers influence consumer choice through service. If price competition among retailers is strong, a manufacturer benefits from introducing minimum RPM as it incentivizes retailers to favor the sales of her product. However, other manufacturers follow into RPM. In the symmetric equilibrium, service is unbiased, but retail margins and consumer prices are higher than without RPM. In turn, manufacturers' profits and social welfare are lower. This challenges the service argument as an efficiency defense for RPM.

JEL classification: D83, L42

Keywords: biased sales advice, common agency, manufacturer dilemma, matching, RPM, vertical restraints

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1 Introduction

The US Supreme Court overturned the long-standing per se illegality of minimum resale price maintenance (RPM)[1] with the Leegin decision of 2007.[2] A controversial debate has accompanied this decision. The European Commission finally decided to maintain minimum and fixed RPM as a core restriction of competition in the renewed vertical block exemption of 2010,[3] but it has modified its vertical guidelines by specifically characterizing circumstances under which minimum RPM may be legal.[4] There is wide consensus both in competition policy and economics that RPM can be harmful by facilitating collusion among manufacturers (Telser, 1960; Motta, 2004; Jullien & Rey, 2007), or at least dampening competition (Rey & Vergé, 2007, Rey & Vergé, 2010). RPM is also considered harmful as a means to facilitate retailing collusion (Marvel & McCafferty, 1984) and as an exclusionary device (Asker & Bar-Isaac, 2011).[5]

The dominant efficiency defense both in Leegin and the European guidelines is that a manufacturer can use minimum RPM to provide retailers with appropriate incentives for service. Most prominent is retailers' free-riding on services that may yield insufficient service under price competition.[6]

The Supreme Court's reasoning in the Leegin decision that manufacturers' and consumers' interests with respect to retail margins are generally aligned is based on Mathewson and Winter (1998).[7] Remarkably, the latter discuss the established service arguments in the context of a *single* manufacturer and exclusive retailers.

The underlying rationale of these service arguments is that in vertical structures with decentralized decision making, individuals do not necessarily make decisions that maximize joint profits. Consider that a retailer's service increases the demand for a product which in turn also benefits the manufacturer. This positive vertical externality can yield too little service (Winter, 1993; Schulz, 2007). Horizontally, free-riding may arise if retailers benefit from each other's services (Telser, 1960). A single manufacturer can mitigate these coordination failures by imposing RPM to make the retailers choose appropriate actions.[8]

[1]Resale price maintenance arises when an upstream firm restricts a downstream firm to on-sell the products of the upstream firm not below a price floor (minimum RPM), not above a price ceiling (maximum RPM) or at a fixed price (RPM).

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

[3]Commission Regulation (EU) No 330/2010 (2010), Article 4a.

[4]EU Guidelines on Vertical Restraints (2010/C 130/01); Paragraph 223 states that an efficiency defense in terms of Article 101,3 TFEU (Treaty on the Functioning of the European Union) is possible also for minimum and fixed RPM. Par. 224 and 225 contain examples of potentially detrimental and beneficial practices, respectively.

[5]Also see Brief by Comanor and Scherer as Amicus Curiae (No. 06-480) in Leegin (cf. fn. 2), p. 8; OECD (2008) Policy Roundtables: Resale Price Maintenance, p. 12.

[6]Paragraph 225 of the EU Vertical Guidelines (cf. fn. 4) explicitly mentions that free-riding on pre-sale advice of retailers in case of complex or experience goods may be a valid efficiency defense for minimum or fixed RPM.

[7]Cf. fn. 2, Opinion of the Court, part C, p. 16.

[8]Similarly, Marvel & McCafferty (1984) model free-riding in the context of costly quality certification by

We do not doubt these well established service arguments according to which the single manufacturer's and consumers' interests are generally aligned with respect to margins of exclusive retailers.[9] Albeit, in many RPM cases including Leegin, competing manufacturers sell through common retailers. However, a manufacturer does not internalize the interests of other manufacturers selling through the common retailer.

In particular, a manufacturer benefits from services biased towards her products to the detriment of competitors and consumers. It is plausible in several RPM cases that retailers have influence on consumers' choices through service. For example, in an attempt to justify the Leegin decision, Elzinga and Mills (2008) cite Bear Stearns Equity Research (2002) to emphasize the role of sales associates in retailing of specialty apparel: *"[I]t is critical that sales associates know the merchandise, have an understanding of the tastes and preferences of the target customer, and can offer fashion and wardrobing advice."* Other recent RPM cases with common retailers and products where pre-sale advice potentially matters include contact lenses[10], hearing devices[11] and consumer electronics.[12] Another case in point are books where RPM is common in several countries.

In this paper, we analyze the incentives of symmetric, differentiated manufacturers to use resale price maintenance in the presence of common retailers that provide non-contractible services such as pre-sale advice. By departing from the single manufacturer assumption predominantly used in the literature on service and RPM, we identify a new rationale for RPM: If retailers can use service to marginally shift demand between competing products, a manufacturer can provide supra-competitive margins through minimum RPM to induce retailers to oversell her products.

We find that if retail price competition is strong relative to retailers' ability to influence consumer choice, a manufacturer can profitably use minimum RPM to relax retail competition on her product. This is the case even when only simple linear tariffs can be used, i.e. when providing retail margins is costly for a manufacturer. If retail price competition is weak, manufacturers use maximum RPM to reduce double marginalization. If both manufacturers can enforce RPM, service is undistorted because both manufacturers use RPM symmetrically, but wholesale and consumer prices are affected.

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retailers. Deneckere, Marvel & Peck (1997) and Krishnan & Winter (2007) introduce demand uncertainty and spillovers in case of stockouts that yield sub-optimal inventories of retailers. RPM can correct for these coordination failures and be beneficial even in terms of consumer surplus. Clearly, a monopoly manufacturer can only profit from having an additional instrument such as RPM to solve her optimization problem and thereby potentially increase vertical efficiency.

[9] It is well recognized in the literature that a mis-alignment may arise also here as the manufacturer optimizes with respect to marginal consumers and competition policy may be concerned about the average consumer. Also see Schulz (2007).

[10] Cf. fine "Bußgeldbescheid B 3 - 123/08," German Federal Cartel Office, September 2009.

[11] Press release "Bundeskartellamt verhängt Bußgeld gegen Hörgerätehersteller Phonak GmbH," German Federal Cartel Office, October 2009.

[12] Cf. press release "Bundeskartellamt verhängt Bußgelder wegen unzulässiger Preisbindung," German Federal Cartel Office, 2003.

We find that minimum RPM always increases consumer prices. For demand linear in prices, minimum RPM reduces manufacturers' profits, but benefits retailers. Hence, the possibility to use minimum RPM creates a prisoner's dilemma for manufacturers. On the contrary, maximum RPM unambiguously reduces consumer prices and increases manufacturer profits to the detriment of retailers.

The detrimental effect of minimum RPM on consumer surplus and manufacturer rents is driven by manufacturers' competition for non-contractible retailer services that increase sales of one product by diverting sales away from other products. By holding the overall service level constant, we show that manufacturers rationally introduce minimum RPM if retail price competition is strong. In equilibrium, this yields higher consumer prices even though service quality is not affected. Furthermore, if only one manufacturer is able to enforce RPM, service and, thereby, consumer choice is distorted in equilibrium. This is in contrast to the common wisdom that RPM is more harmful if frequently used in an industry.

For competition policy, it is crucial to discriminate between cases where free-riding among retailers yields an insufficient level of retailer services and cases in which overall service is not at risk. The danger is that competition policy relies too much on the extensively modeled service arguments with a single manufacturer which - overall - suggest beneficial effects of RPM. Remarkably, several authors have pointed out that the free-riding argument is not substantial in most RPM cases.[13]

Elzinga and Mills (2008) state that *»Leegin's policy bears none of the marks of those economic theories of RPM that have anticompetitive effects.«* The goal of this paper is to shed a more differentiated light on the effects of RPM when competing manufacturers sell through the same service providing retailers. By incorporating manufacturers' competition for favorable retailer services such as pre-sale advice, we demonstrate that providing service incentives may not be a valid efficiency defense for minimum RPM.

Related literature

This paper is clearly related to the aforementioned literature on service and RPM in the context of a single manufacturer. For a recent discussion see Winter (2009). We depart from the predominantly used single manufacturer assumption commonly used to point out that RPM can solve coordination failures in vertical structures. By introducing a second manufacturer, we shed light on the competition for services provided by common retailers - a coordination failure that is worsened by the additional instrument of RPM.

We are aware of two contributions also analyzing RPM in a setting with differentiated manufacturers and common retailers. However, both do not consider service. Rey and Verge

[13] The dissenting Supreme Court Judge Breyer argues in this direction (cf. fn 2) and cites Pitofsky (1984) and Scherer and Ross (1990), pp. 551–552 supporting this view, see also Klein (2009). Grimes (2009) states that *"there has, in fact, been no case before the Supreme Court in which free riding was established as the motivation or justification for imposing RPM".*

(2010) build upon Bernheim and Whinston (1985) to show that monopolization in case of a common agency and two-part tariffs can be extended to competing common agencies if manufacturers can use RPM. Their result relies on efficient two-part tariffs.[14]

Dobson and Waterson (2007) analyze bilateral Nash-bargaining between each manufacturer-retailer pair over a linear wholesale price. They find that if retailers have all the bargaining power, retail prices are higher with RPM. If, instead, manufacturers possess all the bargaining power, retail prices are higher without RPM due to double marginalization. Unfortunately, Dobson & Waterson do not provide a comparison for cases with intermediate bargaining power. Also, they gauge their setting too complex to analyze whether manufacturers would like to use RPM.[15] We take a different approach by allowing manufacturers to make industry wide take-it-or-leave-it offers. Furthermore, we endogenize retailers' buyer power which stems from their abilities to marginally shift demand between products by using service. This increases tractability as retailers do not take discrete decisions.

Influencing retailers' service allocations through RPM has a resemblance to exclusion as analyzed by Asker and Bar-Isaac (2011) and competition for exclusive retailers (Perry and Besanko, 1991; Shaffer, 1992; Foros, Kind & Shaffer, 2011). However, these approaches do not consider marginal service decisions.

Another related literature is that on multi-product advice. Inderst and Ottaviani (2011) analyze the effects of disclosure on commissions that a single intermediary receives from selling competing products such as healthcare services or financials. They find that commissions are higher without disclosure, but that disclosure may lead to an inefficiently small market share of more efficient product providers. In a similar vein, Raskovich (2007) considers how manufacturers influence a single, product information providing retailer through favorable margins. He concludes that *matching competition clauses* may have socially desirable effects. Brekke et al. (2010) consider a pharmacist's decision to persuade patients with a brand-name prescription to purchase a generic drug instead. They provide empirical evidence that pharmacists' marginal monetary incentives have a strong influence on generic drug sales.[16]

These approaches share with our micro-foundation of service that an intermediary's matching advice depends on the products' profitabilities. However, none of these papers considers price competition between retailers and the incentives of a manufacturer to relax this competition by using RPM. Analyzing a manufacturer's individual incentives to use RPM and the resulting competitive effects compared to a situation in which RPM is not feasible is the core of the present paper.

[14]Efficient means that all rents can beextracted through up-front fees.

[15]See Dobson & Waterson (2007), fn. 26.

[16]Other papers dealing with biased retailer advice include Hagiu & Jullien (2011) and White (2009) who investigate why an internet search engine may optimally divert search. Dziuda (2011) shows that an expert can use strategic argumentation to mislead clients searching for the best match, although he is known to be biased. Bolton, Freixas and Shapiro (2010) show that credit rating agencies may mislead naive consumers as long as reputation costs are not too high. Also see Inderst & Ottaviani (2009) for over-selling of a single product in case of multiple retailer services.

Outline

The remainder of this paper is structured as follows: In the next section, we set up the model. The solution is presented in Section 3 with a discussion following in Section 4. We present extensions in Section 5 and conclude in Section 6.

2 Model

2.1 Setting

Two symmetric, differentiated single product manufacturers ($i = A$, B) sell their products to consumers through two symmetric, differentiated multi-product retailers ($k = 1$, 2). We focus on intrinsic common agencies, i.e. take the market structure as given.[17] Marginal costs of manufacturing and retailing are assumed to be constant and normalized to zero. One unit of a product i sold by a retailer requires one unit produced by manufacturer i. All firms are active only if profits are non-negative.

We further assume that a manufacturer is restricted to charge a linear wholesale price w_i that is the same for both retailers.[18] Let $W = (w_A, w_B)$ denote the vector of publicly observable wholesale prices. Hence, no commitment problem of a manufacturer with respect to wholesale prices arises.[19]

Demand for good i at retailer k is denoted by $D_{i,k}(P, S)$ where $P = (p_{A,1}, p_{A,2}, p_{B,1}, p_{B,2})$ is a price vector containing all consumer prices $p_{i,k}$ for any good $i = A, B$ at any retailer $k = 1, 2$. $S = (s_1, s_2)$ denotes the vector of service instruments available to retailer 1 and 2, respectively. The profit of manufacturer i is denoted by[20]

$$\pi_i = w_i \sum_{k=1,2} D_{i,k}(P, S)$$

and the profit of retailer k by

$$R_k = \sum_{i=A,B} (p_{i,k} - w_i) D_{i,k}(P, S).$$

The goal pursued with this model is to investigate the effects of allowing manufacturers to control retail prices when there is discretion of retailers over the allocation of service S. It is

[17] Zhang (1993) shows that common agents can mitigate the incentive problem of selling badly suited products to consumers. Hence, he provides a rationale for why common retailers exist.

[18] Linear wholesale prices may seem restrictive. However, they provide a clear-cut benchmark case in which incentivizing retailers through positive margins is costly for manufacturers. The logic of our argument extends to non-linear contracts as well, see subsection 4.2.

[19] See Rey & Vergé (2004) for a discussion of how RPM helps a single manufacturer who can not commit to wholesale contracts.

[20] The index $x_{i,k}$ denotes that a variable x is specific to manufacturer/product i at retailer k. $-i$ and $-k$ denote the other manufacturer/product and retailer, respectively.

assumed that contracts can not be conditioned on S, i.e. a retailer's service is a non-verifiable action. Although some actions such as specific advertisements can potentially be contracted on, this assumption seems reasonable for other aspects such as pre-sale matching advice.

We restrict our attention to non-collusive behavior, i.e. consider only a one shot game and no horizontal contracts among manufacturers or retailers.[21] Two regimes are considered: (I) RPM is not enforceable, (II) RPM is enforceable and can be introduced unilaterally by any manufacturer in the first stage. If manufacturer i fixes the retail price p_i^R, it must be maintained by both retailers. Note that if a retailer's profit function is single peaked in his retail price, a price fixing (if effectively constraining retailers) acts either as minimum or maximum RPM as a retailer either wants to decrease or increase the price to raise his profits. The timing of the game is as follows:

1. Each manufacturer fixes either only a uniform wholesale price (w_i) or both the wholesale and the retail price (w_i, p_i^R) (in regime (II) if RPM is used by manufacturer i).
2. Each retailer observes the prices fixed by manufacturers and sets his retail prices $p_{i,k}$ (restricted to $p_{i,k} = p_i^R$ under regime (II) if manufacturer i uses RPM) and allocates service s_k.
3. Demand realizes.

Backward induction is used to solve the game for subgame perfect Nash equilibria. An equilibrium is characterized by the price and service vectors W, P, S and manufacturers' decisions to employ RPM under regime (II). For an overview, see Figure 1.

[21] See Jullien & Rey (2007) for RPM facilitating manufacturer collusion in a repeated game with idiosyncratic demand shocks at the retailer level.

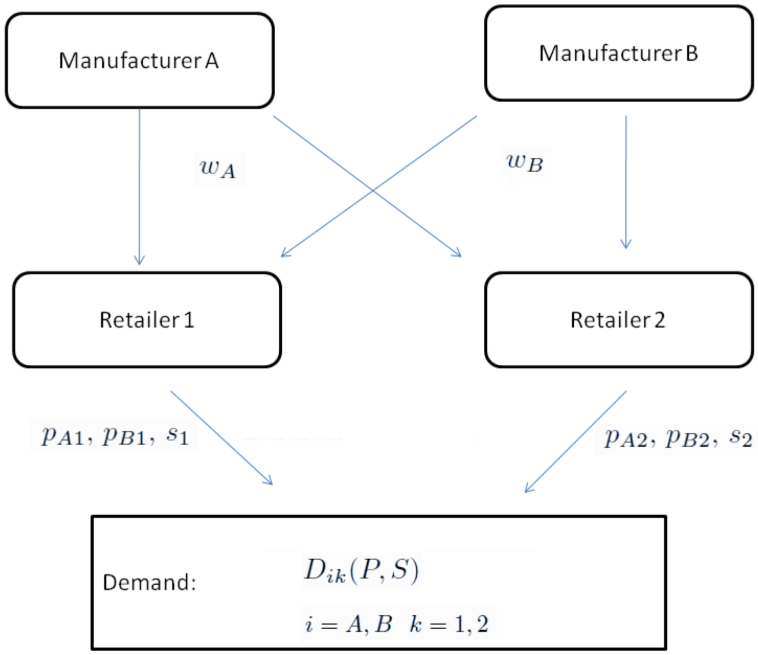

Figure 1: Industry structure

2.2 Demand

For many products such as shoes, clothing, contact lenses and glasses, OTC pharmaceuticals, books, several financial and travel services, retailers commonly carry differentiated products of several manufacturers. On the other side, incompletely informed consumers often seek pre-sale advice from retailers to find the best match. Consequently, a retailer tends to have some discretion to influence which product is being chosen by a consumer. Both Raskovich (2007) and Inderst and Ottaviani (2011) show that the sales agent may use such discretion to steer demand towards more profitable products. In line with these papers, we assume that retailers are better informed than consumers about match suitability among horizontally differentiated products.

Consider the following situation: Consumers are ex-ante uninformed about the existence of two symmetric products A and B and their valuations for both. However, it is common knowledge that to each consumer only one of the two products provides positive utility. When a consumer visits a retailer and asks for advice, the retailer receives a noisy signal which corresponds to the probability that the particular consumer likes product A, and with complementary probability product B. Upon receiving the signal, the retailer can present one product to the consumer.[22] A retailer's choice of which product to present to which consumer

[22]More generally, if a consumer has limited attention or time, a retailer will only be able to present a subset

is captured by the service allocation s_k. This corresponds to a threshold probability such that the retailer advises a consumer towards product A if the probability that the consumer prefers that product is above the threshold level, and product B otherwise. The signals a retailer receives over consumers' preferences are symmetrically distributed around zero such that $s_k = 0$ denotes unbiased advice, i.e. the likelihood of a successful match is maximized. After the product presentation, each consumer is equipped with existence information of that product. In a next step she learns her valuations and the prices at both differentiated retailers, for example by consulting friends or browsing the internet.[23] Hence, consumers are completely informed when they choose if and where to buy a single unit of the preferred product. However, a consumer that has been presented a product that provides her with non-positive utility is assumed to stop searching. In consequence, retailers loose potential buyers when they provide biased advice.

This yields the following functional form of demand for product i at retailer k:

$$D_{i,k} = d_{i,k}(p_{i,k}, p_{i,-k})\, M_i(s_1, s_2) \tag{1}$$

For a more detailed derivation of this demand, see Appendix B. $D_{i,k}$ has the notable feature that it is multiplicatively separable into two components: Firstly, M_i, which is the aggregate mass of consumers that are informed about product i and prefer it over product $-i$ ($\neq i$). Secondly, $d_{i,k}(p_{i,k}, p_{i,-k})$, which denotes the probability that a consumer who has been successfully matched to product i purchases the product from retailer k.

We assume that retailers independently contribute to a pool of consumers interested in a specific product, M_i which is given by

$$\text{(A0)} \quad M_i = m_{i,1}(s_1) + m_{i,2}(s_2).$$

$m_{i,k}$ denotes the mass of consumers successfully matched to product i by retailer k. Recall that a consumer obtains positive utility from at most one of the two products. Thus to a consumer matched with a product that provides him positive gross utility, prices for the other product are irrelevant. In consequence, $d_{i,k}(p_{i,k}, p_{i,-k})$ depends only on $P_i = (p_{i,k},\, p_{i,-k})$ (A1). Hence, the consumer is completely informed about payoff relevant states at the point of purchase. However, a consumer only buys a good match if her idiosyncratic valuation net of additional shopping costs and price is positive.[24]

For technical tractability we assume that $m_{i,k}(s_k)$ is non-negative and twice continuously differentiable. Furthermore, products are symmetric and demand can be influenced

of the products that potentially interest the consumer.

[23]The underlying rationale is that price information is less costly to obtain than match information. For tractability, we therefore abstract from additionally considering price search explicitly.

[24]Ruling out that the decision of buying product i depends on prices of product $-i$ and having pricing decision independent of the matching decision considerably increases tractability, but does not drive the results. See subsection 5.1 for a extension with direct price competition.

monotonically by retailers through s_k with $\partial_{s_k} m_{A,k}(s_k) > 0 > \partial_{s_k} m_{B,k}(s_k)$.[25] Symmetry of the products implies $m_{-i,k}(s_k) = m_{i,k}(-s_k)$ and, in turn, the aggregate mass of successful matches over both products induced by retailer k can be represented by $m_{i,k}(s_k) + m_{i,k}(-s_k)$.

The notion that biasing advice reduces the likelihood of successful matches is captured in the assumption that $m_{i,k}(s_k)$ is strictly concave in s_k (A2).[26] The aggregate mass of successful matches by a retailer is maximized when advice is unbiased, i.e. $0 = \arg\max_{s_k}(m_{i,k}(s_k) + m_{-i,k}(s_k))$. We normalize $M_i(0,0) \equiv 1$.

Recall that our setup implies that for equal retail prices, confronting consumers who apparently have a preference for product A with product B instead, reduces the likelihood that the consumer will eventually buy any product. Similarly, for experience goods, bad matches may cause no loss of demand in the current period, but a low match quality is likely to decrease a retailer's future demand due to fewer repeated purchases or a worse reputation for good advice, cf. Inderst and Ottaviani (2011). The effectiveness of the service instruments is defined by the size of this trade-off, i.e. the smaller the total loss for a given shift, the more effective the instrument.

Definition 1. Let

$$\lambda \equiv \frac{\left(\partial_{s_k} m_{i,k}(0)\right)^2}{-\partial_{(s_k)^2} m_{i,k}(0)}$$

denote the ability of a retailer k to shift demand when starting at the neutral point of $s_k = 0$, $\lambda \in (0, \infty)$.

λ measures the curvature of $m_{i,k}$ evaluated at $s_k = 0$. The greater λ is, the less costly it is for a retailer to shift demand. Intuitively, the more concave $m_{i,k}(s_k)$ is, the more total demand decreases when moving away from the neutral position of $s_k = 0$ at which $m_{A,k}(s_k) + m_{B,k}(-s_k)$ is maximized. In the following, we also call λ the intensity of manufacturers' competition for retailer services.

We finally impose the following standard demand assumptions on $d_{i,k}(p_{i,k}, p_{i,-k})$:

$$\begin{aligned}
&\text{(A3)} \quad -\partial_{p_{i,k}} d_{i,k}(p_{i,k}, p_{i,-k}) > \partial_{p_{i,-k}} d_{i,k}(p_{i,k}, p_{i,-k}) > 0,\\
&\text{(A4)} \quad |\partial^2_{(p_{i,l})^2} d_{i,k}(p_{i,k}, p_{i,-k})| - |\partial^2_{(p_{i,-k} p_{i,k})} d_{i,k}(p_{i,k}, p_{i,-k})| \geq 0,\\
&\text{(A5)} \quad \partial^2_{(p_{i,l})^2} d_{i,k}(p_{i,k}, p_{i,-k}) \leq 0 \quad l = k, -k.
\end{aligned}$$

Assumption (A3) states that the own price effect is negative and dominates the positive cross price effect in magnitude. This is standard for imperfect substitutes. Assumptions (A4) and

[25] We denote by $\partial_x f$ the partial derivative of f with respect to x.

[26] Note that these assumptions imply that for any positive constant z, $m_{i,k}(s) + z\, m_{i,k}(-s)$ has a unique maximizer characterized by the FOC $\partial_s m_{i,k}(s) - z\, \partial_s m_{i,k}(-s) = 0$.

(A5) ensure (weak) concavity of demand and in turn the existence of a unique solution to retailers' pricing for each product i that is not subject to RPM.[27] For notational convenience, we sometimes use the shortcuts $d_{i,k}(p) \equiv d_{i,k}(p,p)$ and $\partial_{p_i} d_{i,k}(p) \equiv \partial_{p_{i,k}} d_{i,k}(p,p) + \partial_{p_{i,-k}} d_{i,k}(p,p)$.

Note that the pre-sale service provided at a retailer has positive rather than negative externalities on the other retailer. In other words, we allow for retailers' free riding on each others' services (retailer k benefits from matches of retailer $-k$). This does not necessarily imply a market failure even if service is costly at the margin because retailers may charge a price for the matching service. Alternatively, one can assume that consumer who seek advice only consider buying at the service providing retailer while, additionally, there are consumers ex-ante informed who consider buying at both stores. If price discrimination between informed and uninformed consumers is not feasible, the resulting demand function has similar properties.

We take the precision of the retailers screening to be exogenous. Hence, the service quality, i.e. how successful retailers match consumers to products is only influenced by a retailer's bias. A retailer's decision over s_k may depend on the margins earned on each product A and B. However, as signal precision is not affected, the mass of successfully adviced consumers by a retailer k, $m_{i,k}(s_k) + m_{-i,k}(s_k)$, does not increase as all margins increase.

Naturally, one may endogenize the precision of the screening and, so to speak, the overall level of service. However, by keeping the overall service level constant, we provide a clear demonstration that RPM may be desirable for manufacturers to increase incentives for special service without having an overall positive service effect. The previous literature on RPM and service has intensively analyzed the effect of retail margins on product specific service. Including this effect would not add much too the model. It is clear that in specific competition policy cases, both effects need to accounted for. We further discuss this issue in subsection 4.1.

3 Solution

3.1 A benchmark without service

For this case we assume that retailers have no instrument to shift demand between products. This corresponds to the excluded case of $\partial_{s_k} M_i = \partial_{s_{-k}} M_i = 0$, implying that $\lambda = 0$. Thus, M_i degenerates to a scaling factor normalized to 1 and demand becomes

$$D_{i,k} = d_{i,k}(p_{i,k}, p_{i,-k}).$$

Note that there are no direct price effects between products A and B by assumption $(A1)$. In effect, each manufacturer becomes an upstream monopolist facing two retailers under

[27] In particular, these assumptions imply that the Hessian of d_{ik} has a negative dominant main diagonal.

imperfect competition. Without RPM, a double marginalization problem arises, i.e. the resulting downstream price p^N lies above the monopoly level characterized by

$$p^M \equiv \arg\max_p p\, d_{i,k}(p,p). \tag{2}$$

Instead, if RPM is available, a manufacturer will use it to reduce retail margins to zero. Clearly, there is no reason to incentivize a retailer trough positive margins as he can not influence sales and his outside option is null.[28] The manufacturer will consequently set her wholesale price equal to the monopoly price, i.e. $w^R = p^R = p^M$. In this case, RPM acts as a price ceiling, i.e. each retailer would gain from unilaterally increasing his retailer price above p^R. RPM solves the double marginalization problem of excessively high prices for this vertical structure. This is the classic argument in favor of maximum RPM dating back to at least Spengler (1950).

In the following, we consider the case where retailers have influence on consumer choice, i.e. $\lambda > 0$ as implied by Definition 1. Thus product demands become interdependent and manufacturers have to compete for favorable retail services.

3.2 Equilibrium without resale price maintenance (regime I)

Assume that no manufacturer can use RPM. Consequently, manufacturers only set wholesale prices in the first stage. Different from the benchmark case above, a manufacturer additionally needs to account for the service allocations S that retailers choose in the subgame for given wholesale prices. A retailer's problem is given by

$$\max_{p_{A,k},p_{B,k},s_k} R_k = \sum_{i\in A,B} (p_{i,k} - w_i) d_{i,k}(p_{i,k}, p_{i,-k})\, M_i(S).$$

Differentiating R_k with respect to $p_{i,k}$ and imposing symmetry $p_{i,k} = p_{i,-k} = p_i^*$ on the FOC yields

$$d_{i,k}(p_i^*, p_i^*) + (p_i^* - w_i)\, \partial_{p_{i,k}} d_{i,k}(p_i^*, p_i^*) = 0. \tag{3}$$

Assumptions (A4) and (A5) on the concavity of $d_{i,k}(\cdot)$ imply that condition (3) characterizes the relationship between retail and wholesale price, denoted by $p_i^*(w_i)$. Observe that a retailer sets prices in best reply to the other retailer's prices to maximize the profitability of each product, i.e. $(p_{i,k} - w_i)d_{i,k}(p_{i,k}, p_{i,-k})$. This decision is independent of the mass M_i of consumers demanding that product. Furthermore, $p_i^*(w_i)$ is independent of the other wholesale price w_{-i}. This follows from assumption $(A1)$ of no direct cross price effects between products. Thus a retailer's pricing decision is separable from her service decision. In summary:

[28] We neglect that market structure may adjust in response to different margins. This is in line with most of the literature on RPM; notable exceptions are Perry & Porter (1990) and Reisinger & Schnitzer (2010). See subsection 4.1 for a discussion on retailing costs.

Lemma 1. *If demand is given by* (1) *and manufacturer i does not use RPM, the price $p_i^*(w_i)$ set by each retailer in the unique symmetric equilibrium of the retailing subgame increases monotonically in the manufacturer's wholesale price w_i, but is independent of M_i and w_{-i}. The retail margin $p_i^*(w_i)-w_i$ decreases monotonically in w_i and in the intensity of competition between retailers.*

Proof. Omitted proofs are in the appendix. □

The regularity assumption and in particular strict concavity ($A6$) on $m_{i,k}$ imply that the optimal interior service allocation s_k^* for a retailer is characterized by the respective FOC, evaluated at profit maximizing prices $p_i^*(w_i)$, i.e.

$$\partial_{s_k} R_k = \partial_{s_k} m_{i,k}(s_k^*)(p_i^* - w_i)\, d_{i,k}(p_i^*) + \partial_{s_k} m_{-i,k}(s_k^*)\,(p_{-i}^* - w_{-i})\, d_{-i,k}(p_{-i}^*) = 0. \tag{4}$$

Intuitively, a retailer uses his service instrument to shift mass to the product that is more profitable. For symmetric wholesale and - strictly larger - retail prices, the condition reduces to $\partial_{s_k} m_{i,k}(s_k^*)+\partial_{s_k} m_{-i,k}(s_k^*) = 0$. This is uniquely solved by $s_k^* = 0$ because biasing decreases total demand due to assumption ($A6$). If exactly one margin is zero, s_k is set to maximize demand for the other product. If both margins are zero, the retailer is indifferent between all s_k.

Without RPM, a manufacturer can only increase the profitability of her product for retailers by lowering her wholesale price.[29] But that suffices to introduce competition among manucturers for favorable service allocations.

Lemma 2. *Without RPM, an increase of manufacturer i's wholesale price w_i induces retailers to allocate service away from product i by adjusting s_k. The marginal effect of an increase of w_i on service set by retailers, evaluated at symmetric wholesale and retail prices $w_A = w_B = w^N$ and $p_A^* = p_B^* = p^N$, is symmetric, i.e.*

$$d_{w_A} s^*(w^N, w^N) = -d_{w_B} s^*(w^N, w^N)$$

with

$$d_{w_A} s^*(w^N, w^N) \;\; = \frac{\partial_{s_k} m_{i,k}(0)}{-2\partial_{(s_k)^2} m_{i,k}(0)} \left[\frac{(\partial_{w_i} p_i^*(w^N) - 1)}{(p^N - w^N)} + \frac{\partial_{p_i} d_{i,k}(p^*(w^N))\partial_{w_i} p_i^*(w^N)}{d_{ik}(p^N)} \right] \;\; < 0. \tag{5}$$

A manufacturer takes the retailers' price setting and service allocation into account when solving

$$\max_{w_i} \pi_i = w_i\, d_i(p_i^*(w_i)) M_i(S^*(W)). \tag{6}$$

[29] This is possible as the derivative of a retailer's expected profit from a consumer informed about product i with respect to w_i is negative, i.e. $\partial_{w_i}\left((p_i^* - w_i)\, d_{ik}(p_i^*)\right) = (\partial_{w_i} p_i^* - 1) d_{ik}(p_i^*) + (p_i^* - w_i)\partial_{p_i} d_{ik}(p_i^*)\partial_{w_i} p_i^* < 0$ for non-extreme competition at the retailing level because then $(p_i^* - w_i) > 0$ and $\partial_{w_i} p_i^* < 1$.

To ensure that a symmetric equilibrium exists, we assume that reduced form profits $\pi_i(w_i, w_{-i})$ are quasi-concave in w_i (A6) and that the equilibrium is locally stable. By symmetry of the objective functions, this amounts to $|\partial^2_{w_i w_{-i}} \pi_i(w^N, w^N)/\partial^2_{w_i w_i} \pi_i(w^N, w^N)| < 1$ where w^N denotes the equilibrium wholesale price (A7). This holds for reasonable parametrizations of demand.[30] Differentiating π_i with respect to w_i, applying symmetry $w_A = w_B \equiv w^N$ and substituting λ using Definition 1 yields the FOC

$$d_{w_i}\pi_i = d_{i,k}(p^N)+w^N \left[\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) + \lambda \left(\partial_{p_{i,k}} d_{i,k}(p^N) + \partial_{p_{i-k}} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N)\right)\right] = 0.$$

There is essentially the usual trade-off between price and quantity, with the particularity that the quantity effect works through two channels: The one is the standard channel of a higher retail price and thus a decreased likelihood that a consumer is willing to buy the product. This is the first summand in the brackets. The other channel is the reduced retailer profitability of the product induced by increased input costs w_i. In consequence, retailers allocate service and, thereby, potential buyers away from product i.

Note that the marginal profit decreases in λ. Intuitively, the fewer interested buyers a retailer looses when proposing the more profitable product, the more he is willing to reallocate service in response to an increased profitability of a product. If retailers cannot influence consumer choice at all, i.e. $\lambda = 0$, the equilibrium is that of the benchmark case in 3.1 where M_i is exogenous and a manufacturer acts as a monopolist facing retailers in imperfect competition.

Proposition 1. *Without RPM, the symmetric equilibrium wholesale price is given by*

$$w^N = \frac{-d_{i,k}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) + \lambda \left(\partial_{p_{i,k}} d_{i,k}(p^N) + \partial_{p_{i-k}} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N)\right)}. \tag{7}$$

The equilibrium wholesale price w^N decreases in retailers' ability to shift demand, i.e. $\partial_\lambda w^N < 0$. The equilibrium retail price without RPM is characterized by

$$p^N = w^N + \frac{d_{i,k}(p^N)}{-\partial_{p_{i,k}} d_{ik}(p^N)}. \tag{8}$$

Retailers' equilibrium margins decreases in w^N as $0 < \partial_{w_i} p_i^* < 1$.

Note that the wholesale price in equation (7) is implicitly defined as p^N is a function of the wholesale price. Still, under the assumption $(A7)$ of local stability of the equilibrium, it can be shown that the wholesale price decreases as retailers' ability to steer demand, λ, increases.

[30] For example, if $d_{i,k}(p_{i,k}, p_{i,-k})$ is linear in prices and $m_{A,k} = 4/6(1 - (-s_k + 0.5)^2) = m_{B,k}(-s_k)$ this property is fulfilled. See Appendix B for a sketch of the derivation of $m_{i,k}$.

3.3 Equilibrium with resale price maintenance (regime II)

Consider that no manufacturer has used RPM before, but now RPM becomes feasible for manufacturer A. Manufacturer A can reproduce the equilibrium prices without RPM by setting $p_A^R = p^N$ and $w_A^R = w^N$. Hence, she is at least as good off when deviating to use RPM.[31] Manufacturer A using RPM faces the following trade-offs:

- decreasing w_A reduces her own margin, but increases the retail margin $p_A - w_A$, i.e. induces retailers to increase the sales of product A using service;
- increasing p_A decreases the likelihood $d_A(p_A, p_A)$ that consumers are willing to buy product A but increases the retail margin.

To ensure the existence of a symmetric equilibrium, we again assume that $\pi_i(w_i, p_i)$ is quasi-concave in both w_i and p_i. Again, this holds under reasonable demand parametrizations.[32]

Given the two instruments (w_A, p_A), it is shown in the proof to Lemma 3 that it is optimal for the manufacturer to set the monopoly price $p_A^R = p^M$ to maximize the joint rent obtainable from her product, independent of the prices of the other product. Intuitively, this is the case because we have assumed away direct price competition among the two products to keep the model tractable. Otherwise, the retail price is in general a function of the competitor's retail price, see Section 5.1 for this extension. However, in the present setting a manufacturer sets $p_A^R = p^M$ and w_A to maximize

$$\pi_A = w_A\, d_A(p^M, p^M)\, M_A(S^*(w_A, p_A^R = p^M | w_B, p_B)),$$

thereby trading off the benefit of increasing her per unit profit w_A with the marginal loss of consumers due to the decreased incentive $p^M - w_A$ of the retailers. In summary:

Lemma 3. *A manufacturer i has an individual incentive to introduce RPM and set $p_i^R = p^M$.*

Since it is a manufacturer's dominant strategy to use RPM and set the retail price at the monopoly level, it is immediately clear that both manufacturers will do so in any equilibrium in which both use RPM. The optimal wholesale price, however, depends on the other manufacturer's wholesale price.

Proposition 2. *In the unique symmetric equilibrium with RPM, the wholesale price w^R is given by*

$$w^R = \frac{p^M}{1+\lambda}. \tag{9}$$

[31] It is not surprising to see that the additional instrument is used if a manufacturer can not commit to not use it. However, one can show that equilibria with RPM still exist if the choice of RPM is made beforehand in a stage 0. Note also that RPM is only unambigously dominant here as there are by assumption no enforcement costs.

[32] The parametrization in fn. 30 again does the job.

The wholesale price is weakly smaller than the retail price, i.e. $w^R \leq p^M$*, and decreases in the ability of retailers to shift demand,* λ*.*

3.4 Competitive effects of RPM

A unilateral introduction of RPM is always weakly profitable for a manufacturer. However, collectively manufacturers can be worse off, i.e. the enforceability of RPM can impose a prisoner's dilemma on manufacturers.

Resale price maintenance imposes a *dilemma* for manufacturers if and only if the equilibrium profit of a manufacturer is lower in case RPM is enforceable than in case it is not enforceable, i.e.

$$\pi_i^R = w^R\, d_i(p^R, p^R) < w^N\, d_i(p^N, p^N) = \pi_i^N.$$

RPM allows a manufacturer to maximize the profit for the vertical structure by either avoiding double marginalization or increasing the retail prices of her product to the monopoly level. However, RPM eliminates intra-brand price competition of retailers and allows a manufacturer to directly control the retail margin on her product. This additional control induces manufacturers to compete harder for retail services and can thus be collectively undesirable for manufacturers.

We model RPM as price fixing. However, if RPM is a binding constraint to retailers, it acts either as a price floor or a price ceiling. These two cases can be distinguished by answering the simple question: Would a retailer profit from reducing or increasing the price relative to the price fixed by the manufacturer? By evaluating the retailers' FOC with respect to retail prices, we obtain the following:

Lemma 4. *In equilibrium, manufacturers use RPM as a price floor if and only if*

$$\lambda \quad > \quad \frac{-\partial_{p_{i,k}} d_{i,k}(p^M, p^M)}{\partial_{p_{i,-k}} d_{i,k}(p^M, p^M)} - 1. \tag{10}$$

If the above inequality is reversed, manufacturers use RPM as a price ceiling. In case of equality, there is effectively no RPM.

We identify two countervailing drivers that determine whether RPM is used as a price floor or a price ceiling: Service competition and double marginalization. A manufacturer has an incentive to use minimum RPM to raise the retail margin of her product to induce favorable retailer services. This desire becomes the more important, the better retailers can influence demand, i.e. the larger λ is. However, without RPM, retailers already add margins on top of manufacturers' wholesale prices. If intra-brand price competition is weak relative to retailer's ability to influence consumer choice, a manufacturer desires to use maximum RPM to decrease the retail margin.

For example, consider that retailers face hardly any price competition. Then the RHS of the above inequality (10) becomes very large as the price effect $\partial_{p_{i,-k}} d_{i,k}(p^M, p^M)$ is close to zero. For a given level of retailers' ability to steer demand, λ, sufficiently weak retail price competition implies that manufacturers use maximum RPM. On the contrary, if retail competition is close to Bertrand, the RHS of (10) is close to zero and the inequality holds even for very weak retailer influence on consumers' product choices (λ close to zero).

For a given level of overall service, the essential question from a welfare point of view is whether RPM increases prices and harms consumers. From a competition policy perspective, a related and important question is whether the effects of minimum and maximum RPM can be clearly distinguished in the sense that only minimum RPM can harm consumers.

First, we establish the condition under which the enforceability and, in equilibrium, the use of RPM increases consumer prices.

Lemma 5. *RPM increases equilibrium prices, i.e. the monopoly price set under RPM, p^M, is higher than the price if no manufacturer uses RPM, p^N, if and only if*

$$\lambda > \frac{-\partial_{p_{i,k}} d_{i,k}(p^N, p^N)}{\partial_{p_{i,-k}} d_{i,k}(p^N, p^N)} - 1. \tag{11}$$

Correspondingly, RPM decreases consumer prices iff the above inequality is reversed. For $\lambda = \lambda^M \equiv \frac{-\partial_{p_{i,k}} d_{i,k}(p^N, p^N)}{\partial_{p_{i,-k}} d_{i,k}(p^N, p^N)} - 1$, RPM has no price effect.

Comparing the conditions for minimum RPM (10) and a consumer price increase through RPM (11) reveals a striking similarity. The same effects as for minimum can be identified: More service competition among manufacturers and harsher retailer price competition, i.e. lower double marginalization in case of no RPM, favor RPM to be price increasing. Furthermore it can be shown that:

Proposition 3. *Minimum RPM always increases consumer prices and maximum RPM always decreases consumer prices. Therefore, banning minimum RPM and allowing maximum RPM is welfare optimal.*

For an intuition of the proof, consider that $\lambda = \lambda^M$. It follows that $p^N = p^M$ and the right hand sides of condition (10) and (11) coincide. Hence, there is neither maximum nor minimum RPM. Raising λ above λ^M decreases p^N (i.e. condition (11) holds) and implies that the minimum RPM condition (10) holds. Analogously, for a decrease of λ below λ^M, p^N increases and maximum RPM results.

Proposition 3 suggests a simple optimal policy which is to forbid minimum RPM as it unambiguously increases consumer prices. This is a clear-cut result. However, a caveat applies. Symmetric increases of retail margins in our model have no positive welfare effect as they do not affect the overall quality of service that is exogenous to the model. See subsection 4.1 for a discussion of the case when overall service quality depends on the overall level of retail margins. Still, the result provides a clear benchmark that minimum RPM is harmful if there is no threat that the overall level of service for this product category would be socially insufficient without RPM.

Furthermore, it is noteworthy that a manufacturer individually desires to introduce minimum RPM to increase retailer services for her product, although collectively manufacturers may loose. Indeed, it can be shown that:

Lemma 6. *If demand is linear in prices, banning minimum RPM is both in the interest of consumers and manufacturers while maximum RPM benefits these parties. For retailers, the reverse holds.*

For linear demand, increasing the profit pie of the supply side by using minimum RPM is collectively never in the interest of manufacturers. A caveat applies, as this result is derived for linear wholesale contracts, see 4.2 for a further discussion of this issue. Nevertheless, it is apparently the first time that it has been formally shown that minimum RPM can impose a prisoner's dilemma on manufacturers.

4 Discussion

The previous analysis has revealed a pattern that can be summarized as follows: If retailers' price competition is strong relative to retailers' ability to influence consumer choice, each manufacturer individually attempts to introduce minimum RPM to increase retailers' incentives to bias service towards her product.

From a single manufacturer's perspective, raising retail margins through minimum RPM increases incentives for service and yields more special service for her products. Hence, a manufacturer can demonstrate that her usage of minimum RPM is effective in increasing services for her products that are (from his perspective) underprovided if there is strong price competition of retailers.

In the EU, such a demonstration may lead to an efficiency defense according to TFEU 101,3 as sketched by the new EU vertical guidelines, cf. fn. 4. However, if the current model applies and manufacturers compete for special retailer services (e.g. favored sales advice), there is no efficiency gain induced by minimum RPM. Asymmetric RPM may even worsen consumer choice.

4.1 Endogenizing the overall service level

A central efficiency argument in favor of minimum RPM is that retailers can free ride upon costly service. Note that free-riding occurs in the present model because consumers who are matched by the one retailer can also buy at the other retailer, hence both retailers benefit from each others' matching services. However, so far no inefficiency through free-riding arose as the overall level of service does not depend on retail margins.

Instead, consider that a service-providing retailer has to invest in matching quality and costs are increasing in the precision of the signal. If the retailer can not charge for the matching service and price competition with the other retailer forces margins towards zero on each product, the signal may be insufficiently precise in equilibrium. In principle, a vertical restraint such as RPM can increase efficiency in this case. However, recall that this argument - as well as the present model - abstracts from a consumer's choices of where to seek advice in the first place. This becomes relevant if signal quality is endogenous.

However, if the signal quality chosen by each retailer is observed by the manufacturers before they set prices, retailers may have an incentive to be less informed, i.e. to choose lower signal qualities. For an intuition, consider two extremes: If each retailer is perfectly informed about each consumer's preference, differences in products' profitabilities do not change the service allocations. Instead, if each retailer receives an uninformative signal for each consumer, they will advice all consumers to the more profitable product. It is straight forward that a manufacturer has a stronger incentives to ensure a high retail profitability of her product in the latter case. Furthermore, RPM enhances a manufacturer's ability to influence this retail profitability by directly setting the retail margin. Hence, it is likely that retailers have a stronger incentive to be less informed in case manufacturers can use RPM.

Furthermore, it is not clear that a manufacturer is individually willing to finance a multi-brand retailer's matching services such as pre-sale advice that would benefit all manufacturers. Increasing retailers' profits through minimum RPM seems more plausible if the high margins induce retailers to particularly favor the sales of the granting manufacturer's products.[33]

A case in point is a recent antitrust case in which Ciba Vision, a manufacturer of contact lenses, effectively used RPM through recommended retail prices and price monitoring to undermine price erosion through opticians' distribution via the internet.[34] This case fits well to our argument: Opticians provide intensive matching services for contact lenses of several manufacturers that are not likely to break down if the margins for one manufacturer are low. Opticians may even charge consumers for fitting contact lenses, hence underprovision of matching services may not be an issue. However, opticians are potentially inclined to fit rather those lenses on which margins are high, not least to make profits from repurchases.[35]

Interestingly, manufacturers' individual incentives to bias matching may actually yield a socially desirable level of service quality in spite of its public good properties for a single manufacturer. This could occur if matching quality is insufficient without RPM and the

[33]Even with only a single manufacturer, the desired level of service may differ between manufacturer and the average consumer as the former optimization accounts for the marginal consumer's preferences, see for example Schulz (2007).

[34]Cf. fn. 10.

[35]For an antitrust analysis of free-riding and RPM in the context of internet retailing see Lao (2010).

quality of matching depends positively on retail margins.

However, if the overall level of service is not insufficient without RPM, minimum RPM potentially yields excessive retail profits, excessive service or excessive entry at the retail level.

4.2 Non-linear wholesale contracts

The assumption of linear wholesale contracts is also made by Dobson & Waterson (2007). That more sophisticated two-part tariffs are not necessary for minimum RPM to be harmful is a point in itself. Our result of a competitive dilemma relies on the assumption that providing retail margins is costly for a manufacturer (i.e. a manufacturer can not fully extract rents through two-part tariffs), but it does not rely on linear tariffs.

Consider that competition drives retail margins close to zero without RPM and that there is service competition. Note that a manufacturer, say A, could offer contracts to retailers that impose a positive margin on her products via RPM and additionally ask them to transfer all additional profits. The marginal decision of retailers remains unaffected by the lump-sum fees. Hence, retailers match consumers excessively to products of type A which benefits the manufacturer without costs to her due to the lump-sum fee.

If both manufacturers use lump-sum fees, each has to consider that retailers' opportunity profit to paying the fee and carrying an additional brand is that of exclusively carrying the other brand. This opportunity profit is generally not zero. This by itself puts a limit on the fee level. See Rey & Vergé (2010) for a more detailed discussion of this issue.

However, if for exogenous reasons the lump sum-fees are restricted to be small (e.g., because wholesale arbitrage is feasible to retailers, retailers' risk aversion or rebate arrangements are forbidden), for small enough fees both retailers will carry both products and the manufacturer dilemma prevails.

4.3 Price erosion

"In the experience of the Bundeskartellamt, as regards the pricing of products, an important concern for producers is downward pressure on prices at the retail level. In that respect, e-mail or other correspondence by producers telling resellers that they are selling a high quality product which must therefore not be sold at low prices is not uncommon. Producers seem to be afraid that a general erosion of prices charged to the final consumer will ultimately lead to retailers bargaining harder and demanding lower prices from their suppliers. One objective of producers therefore is to secure stable (high) prices."[36]

This statement is puzzling in a setting with a single manufacturer. Suppose that with RPM, wholesale and retail prices are given by (w^R, p^R). If now minimum RPM is abolished,

[36] Cf. OECD (2008), p. 143

a lower retail price level $p^*(w^R) < p^R$ will result. As $\partial_w p^* > 0$, the retail price level p^R can easily be restored by setting a higher wholesale price. Hence, price erosion can easily be avoided.

However, the argument of price erosion in the sense of lower wholesale prices is understandable in light of competition for retail services. Consider an equilibrium with strong, but imperfect retailer competition and minimum RPM as characterized in Lemma 4. Assume now that manufacturer B cannot use RPM anymore (e.g. because of an antitrust litigation or because retailer coordination on a recommended retail price breaks down). Hence, price setting takes place with one manufacturer using RPM (say A) and the other one (say B) not. Due to strong retailer competition, any retail margin $p^*_B(w_B) - w_B$ on product B will be relatively small while manufacturer A can freely set the margin $p_A - w_A$. Retailers' expected profit of selling a unit of product B, $d_{B,k}(p^*(w_B))\,(p^*_B(w_B) - w_B)$, decreases in w_B and so does M_B as service adjusts in wholesale prices. Intuitively, it may be optimal for manufacturer B to set a low w_B in order to sustain incentives of retailers to sell product B.

Solving the asymmetric game in reduced form is involved as implicit derivatives have to be evaluated at various points. Therefore, we solve the game for $M_B(s) = {}^1\!/\!_2(1-(s+0.5)^2),\ \ s \in [-0.5, 0.5]$ (analogously for A) and $d_{i,k}(P_i) = \frac{\alpha}{\beta+\gamma} - \frac{\beta}{\beta^2-\gamma^2}\, p_{i,k} + \frac{\gamma}{\beta^2-\gamma^2}\, p_{i-k}$ with $\alpha = 0.3$, $\beta = 0.2$, $\gamma = 0.198$. This yields $w_A = {}^{13}\!/\!_{100}$, $p_A = p^M = {}^{15}\!/\!_{100}$, $w_B = {}^{9.4}\!/\!_{100}$, $p_B = {}^{9.6}\!/\!_{100}$. Service is still tilted towards product A ($s = 0.21$). With symmetric RPM, $w^R = {}^{10}\!/\!_{100}$. Hence, under asymmetric RPM manufacturer B optimally sets a lower wholesale price than under symmetric RPM to increase demand.

This retail price "erosion" fits well with the above citation, even without modeling bargaining explicitly. The logic is related, however: The instrument of RPM allows a manufacturer to increase the pie of the vertical chain and at the same time secure retailers a larger share that incentivizes sales of product B. In the above specification price erosion occurs for γ close to β, i.e. strong retailing competition.

4.4 Asymmetric resale price maintenance and service quality

If RPM is enforceable, using it is a dominant strategy for a manufacturer. This yields a symmetric equilibrium in which both manufacturers use RPM. Consumer harm stems from an increase in the price level. In contrast, imagine that manufacturer B can not enforce RPM while manufacturer A can. If retailer price competition is close to Bertrand, manufacturer A can profitably impose an above-competitive retail margin by introducing minimum RPM. In effect, consumers are dis-proportionately often exposed to the expensive A product as in the numerical example above where consumers c.p. would prefer that service is tilted towards the cheaper product B. In case of pre-sale advice, matching is biased in equilibrium, yielding a low match value and a welfare loss.

This argument, though highly stylized, suggests that the presumption of RPM being more harmful if used by many manufacturers in a market (which may be true if the reason is collusion among manufacturers) may not extend to the case of service competition. Rather, if retail competition is strong, asymmetric RPM tends to cause biased sales advice while symmetric RPM yields unbiased advice but a higher price level.

Similarly, the presumption that RPM is less harmful if used by manufacturers with little market power (often measured as a small market share and possibly low profits) is not straightforward to support in the context of competition for retailer services.[37]

5 Extensions

5.1 Direct inter-brand price competition

Assumption (A1) of no cross price effects between products A and B simplified the previous exposition but is certainly not always correct.

One way to relax this assumption is to assume that there are two types of consumers: Informed and uninformed ones with shares δ and $1-\delta$, respectively. Informed consumers know their match values with both products A and B and hence their demand depends on all four prices but not on service, denote this as $f_{i,k}(P)$. Uninformed consumers demand is the one discussed above, hence overall demand can be written as

$$D_{i,k} = \delta\, f_{i,k}(P) + (1-\delta)\, d_{i,k}(P_i)\, M_{i,k}(S). \tag{12}$$

Note that a retailer's service decision as a function of prices as characterized by (4) remains unaffected. However, a retailer's FOC with respect to price $p_{i,k}$ is now given by

$$\begin{aligned}\delta &\left[(p_{i,k}-w_i)\partial_{p_{i,k}} f_{i,k}(P) + f_{i,k}(P) + (p_{-i,k}-w_{-i})\partial_{p_{i,k}} f_{-i,k}(P)\right] \\ &\quad +(1-\delta)\, M_i(S) \left[(p_{i,k}-w_i)\partial_{p_{i,k}} d_{i,k}(P_i) + d_{i,k}(P_i)\right] \;=\; 0.\end{aligned}$$

Intuitively, the equilibrium price of the subgame is a linear combination of the equilibrium prices when all consumers are informed ($\delta = 1$) and when all are uninformed ($\delta = 0$). Similarly, a manufacturer faces

$$\begin{aligned}\partial_{w_i}\pi_i = (1-\delta)&\left[d_i(p_i^*)\, M_i(S) + w_i\, \partial_{p_i} d_i(p_i^*)\, M_i(S) \mathrm{d}_{w_i} p_i^*(w_i, w_{-i}) + w_i\, d_i(p_i^*)\, \partial_{s_k} M_i(s^*)\, \mathrm{d}_{w_i} s_k^*\right] \\ &+\delta\left[f_i(p_i^*, p_{-i}^*) + w_i\left(\partial_{p_i} f_i(p_i^*, p_{-i}^*)\, \mathrm{d}_{w_i} p_i^* + \partial_{p_{-i}} f_i(p_i^*, p_{-i}^*)\, \mathrm{d}_{w_i} p_{-i}^*\right)\right] = 0.\end{aligned}$$

We conjecture that at least for small δ, the results derived for $\delta = 0$ in the main part of

[37]Interestingly, Foros, Kind & Shaffer (2011) argue that restrictions on the extent of the market that can be covered by RPM as found in the vertical restraints guidelines of the EU and the US may be detrimental to welfare. Their argument is based on the insight of Shaffer (1991) that symmetric RPM is not effective in increasing prices which is unrelated to the matching bias discussed here.

this paper remain qualitatively valid.

Interestingly, another manufacturer's dilemma may arise as the fraction of informed consumers becomes large. Using (maximum) RPM is a manufacturer's dominant strategy in the present timing. However, committing to not control retail prices via RPM may increase profits as it relaxes manufacturers' competition. See Bonanno & Vickers (1988) and Rey & Stiglitz (1995) who elaborate on strategic delegation of retail pricing.

6 Conclusion

In this paper, we analyze the incentives of manufacturers to use resale price maintenance in the presence of common retailers who provide non-contractible services such as pre-sale advice. By departing from the single manufacturer assumption predominantly used in the literature on service and RPM, we identify a new rationale for why manufacturers want to use minimum RPM: If retailers can marginally shift demand between competing products, a manufacturer can induce retailers to oversell her product by reducing retailing competition thereon.

Strong retailing competition implies that each manufacturer can profitably increase retail margins by introducing minimum RPM and thereby increase the sales of her product. This is the case even if only simple linear tariffs can be used, i.e. providing retail margins is costly for a manufacturer. If, instead, retailing competition is weak, manufacturers use maximum RPM to reduce double marginalization.

We find that minimum RPM always increases consumer prices. For demand linear in prices, minimum RPM reduces manufacturers' profits, but benefits retailers. Hence, the possibility to use minimum RPM creates a prisoner's dilemma for manufacturers. On the contrary, maximum RPM unambiguously reduces consumer prices and increases manufacturer profits to the detriment of retailers.

By holding the overall service level constant, we show that manufacturers' competition for retailer services yields minimum RPM and higher consumer prices without any consumer benefit. The detrimental effect of minimum RPM on consumer surplus and manufacturer rents is driven by manufacturers' competition for non-contractible retailer services that increase sales of one product by diverting sales away from the other product.

We thereby broaden the perspective of the service argument with a single manufacturer according to which a manufacturer's and consumers' interests are generally aligned with respect to retail margins. A manufacturer selling through common retailers does not internalize the interests of other manufacturers. If retailers have influence on consumers' choices, a manufacturer benefits from biased advice to the detriment of competitors and consumers.

This sheds new light on the argument often voiced by manufacturers that minimum RPM is necessary to maintain a high price level in order to avoid price erosion and, thereby, incentivize retailers to provide sufficient service.

For competition policy, it is crucial to discriminate between cases where free-riding among retailers yields an insufficient level of retailer services and cases in which overall service is not at risk. The danger is that competition policy relies too much on the extensively modeled free-riding argument with a single manufacturer as in Leegin and the new vertical guidelines of the European Union. Thus, the circumstance that competing manufacturers sell through the same retailers should be appropriately taken into account when evaluating service incentives as an efficiency defense for resale price maintenance.

Recent empirical studies on pharmaceuticals (Brekke, Holmås & Straume, 2010) and financial services (Hackethal, Inderst & Meyer, 2010) indicate that retailers' matching advice is influenced by monetary incentives. RPM has been observed in markets for books, consumer electronics, contact lenses, fashion clothing and hearing devices where consumer influence through sales advice also seems plausible. We believe that the rationale for minimum RPM identified in the present paper extends to cases where product positioning is important, such as groceries. However, the results are derived under simplifying assumptions such as linear tariffs, an exogenous overall level of service and no direct price competition among brands. While we have shown that these assumptions can be relaxed, one has to keep in mind that other effects may overlay the competitive harm pointed out here. Further research along these lines may be fruitful.

Also, there is little empirical evidence on RPM. A recent pathbreaking contribution is Bonnet & Dubois (2010) who argue that RPM and two-part tariffs as modeled by Rey & Vergé (2010) are prevalent in the market for bottled water in France. Interestingly, they do not test against the scenario of minimum RPM and linear tariffs as investigated in the present paper. More empirical research in this area seems promising.

Appendix A: Omitted proofs.

Lemma 1.

Proof. The first order condition of a retailer k for the price of product i is given by:

$$d_{i,k}(P_i) + (p_{i,k} - w_i)\partial_{p_{i,k}} d_{i,k}(P_i) \;\; = \;\; 0.$$

We procede by first showing that a unique symmetric equilibrium for the retailers' pricing game exists. Recall that the assumptions (A2), (A3), (A4) imposed on $d_{i,k}(P_i)$ imply that the price reaction functions are contractions and thereby a unique and symmetric fixed point exists. Hence, there exists a unique symmetric equilibrium for the subgame in which both retailers set a price $p_i^*(w_i)$ that solves

$$d_{i,k}(p^*) + (p^* - w_i)\partial_{p_{i,k}} d_{i,k}(p^*) = 0.$$

This condititon is independent of M_i and w_{-i}. We now show that $0 < \mathrm{d}_{w_i} p_i^* < 1$ holds, i.e. the retail price increases in the wholesale price and retailers' margins for a product i decrease in w_i. The derivative $\partial_{w_i} p_i^*$ can be calculated applying the implicit function theorem on the above equation. This yields

$$\begin{aligned}
\mathrm{d}_{w_i} p_i^* \;\; &= \;\; -\frac{\partial_{w_i}\left(d_{i,k}(p^*) + (p^* - w_i)\partial_{p_{i,k}} d_{i,k}(p^*)\right)}{\partial_{p_i}\left(d_{i,k}(p^*) + (p^* - w_i)2\partial_{p_{i,k}} d_{i,k}(p^*)\right)} \\
&= \;\; -\frac{-\partial_{p_{i,k}} d_{i,k}(p^*)}{\left(\partial_{p_i} d_{i,k}(p^*) + (p^* - w_i)\partial^2_{p_{i,k}p_i} d_{i,k}(p^*) + \partial_{p_{i,k}} d_{i,k}(p^*)\right)} \\
&= \;\; \frac{\partial_{p_{i,k}} d_{i,k}(p^*)}{\left(2\partial_{p_{i,k}} d_{i,k}(p^*) + \partial_{p_{i,-k}} d_{i,k}(p^*) + (p^* - w_i)\left(\partial^2_{p_{i,k}p_{i,k}} d_{i,k}(p^*) + \partial^2_{p_{i,k}p_{i,-k}} d_{i,k}(p^*)\right)\right)}.
\end{aligned}$$

The numerator of the last expression consists of the own price derivative which is clearly negative by (A2). Also, the denominator is negative. The first two summands are negative by (A2) which additionally implies that the own- dominates the cross price effect in magnitude. Assumption (A3) of a dominant diagonal of the Hessian of $d_{i,k}$ implies that $\partial^2_{p_{i,k},p_{i,k}} d_i(p^*) + \partial^2_{p_{i,k},p_{i,-k}} d_i(p^*) \leq 0$ and a negative margin is strictly dominated. Hence, $0 < \mathrm{d}_{w_i} p_i^*$. Clearly, $\mathrm{d}_{w_i} p_i^* < 1$ as the numerator is smaller than the denominator in magnitude.

The margin of a retailer monopoly is characterized by $-d_{i,k}(p)/\left(\partial_{p_{i,k}} d_{i,k}(p) + \partial_{p_{i,-k}} d_{i,k}(p)\right)$. Hence, the ratio in margins for a given p between monopoly and duopoly is given by $1 + \partial_{p_{i,-k}} d_{i,k}(p)/\partial_{p_{i,k}} d_{i,k}(p)$ and therefore the latter summand can be interpreted as the intensity of retailer competition. As competition increases, $\partial_{p_{i,-k}} d_{i,k}(p^*) \to -\partial_{p_{i,k}} d_{i,k}(p^*)$, $p^* - w_i \to 0$ and $\mathrm{d}_{w_i} p_i^* \to 1$. □

Lemma 2.

Proof. To determine the effect of an increase in w_i on the equilibrium service s^* set by both retailers, implicitly differentiate the FOC of a retailer's problem with respect to s_k as given by (4). This yields

$$\frac{ds^*}{dw_i} = \frac{\partial_{s_k} m_{i,k}(s_k)\, \partial_{w_i}(p_i^*(w_i) - w_i) d_{i,k}(p_i^*(w_i))}{\partial_{s_k} m_{i,k}(s_k)(p_i^*(w_i) - w_i) d_{i,k}(p_i^*(w_i)) - \partial_{s_k} m_{i,k}(-s_k)\,(p_{-i}^*(w_{-i}) - w_{-i})\, d_{-i,k}(p_{-i}^*(w_{-i}))}.$$

By symmetry of the products, $m_{i,k}(s_k) = m_{-i,k}(-s_k)$. Substituting this into the retailer's FOC respect to s_k, equation (4), yields:

$$\partial_{s_k} R_k = \partial_{s_k} m_{i,k}(s_k)(p_i^*(w_i) - w_i) d_{i,k}(p_i^*(w_i)) - \partial_{s_k} m_{i,k}(-s_k)\,(p_{-i}^*(w_{-i}) - w_{-i})\, d_{-i,k}(p_{-i}^*(w_{-i})) = 0$$

Using the implicit function theorem gives us

$$\frac{\mathrm{d}s_k^*}{\mathrm{d}w_i} = -\frac{\partial_{s_k} m_{i,k}(s_k)\,[(\partial_{w_i} p_i^* - 1) d_{i,k}(p_i^*(w_i)) + (p_i^*(w_i) - w_i)\partial_{p_i} d_{ik}(p_i^*(w_i))\partial_{w_i} p_i^*]}{\partial^2_{(s_k)^2} m_{i,k}(s_k)\,(p_i^*(w_i) - w_i) d_{i,k}(p_i^*(w_i)) + \partial^2_{(s_k)^2} m_{i,k}(-s_k)\,(p_{-i}^*(w_{-i}) - w_{-i})\, d_{-i,k}(p_{-i}^*(w_{-i}))}.$$

The term in the square bracket is the effect of an increase in a wholesale price w_i on retailer's per unit profit from product i and is clearly negative as $\partial_{w_i} p_i^* < 1$. The denominator is negative as the per unit profit of each product is positive and $\partial^2_{(s_k)^2} m_{i,k}(s_k) < 0$ as well as $\partial^2_{(s_k)^2} m_{i,k}(-s_k) < 0$ by (A6). Thus, $\mathrm{sgn}(\frac{\mathrm{d}s_k^*}{\mathrm{d}w_i}) = \mathrm{sgn}(-\partial_{s_k} m_{i,k}(s_k))$. Hence, if $\partial_{s_k} m_{i,k}(s_k) > 0$, i.e. increasing s_k increases the mass of product i, then increasing w_i decreases s_k. Mass is shifted away from a product when its wholesale price increases.

Substituting into the implicit derivative $\frac{\mathrm{d}s_k^*}{\mathrm{d}w_i}$ the values of the symmetric equilibrium of the complete game without RPM, $(w^N, p^N, s_1 = s_2 = 0)$, yields expression (5). □

Proposition 1.

Proof. Differentiating a manufacturer's profit π_i as in (6) with respect to w_i yields

$$\partial_{w_i} \pi_i \;=\; d_i(p_i^*) M_i(S^*) + w_i \partial_{p_i} d_i(p_i^*) \mathrm{d}_{w_i} p_i^* M_i(S^*) + w_i d_i(p_i^*)\, 2\partial_{s_k} m_{i,k}(s_k^*)\, \mathrm{d}_{w_i} s_k^* = 0.$$

Recall that $d_{i,k}(p) \equiv d_{i,k}(p,p)$. Evaluating this equation at symmetric prices and services ($w_i = w^N, p_i^* = p^N, s_1 = s_2 = 0$, $i = A, B$), implying that $M_i = 1$, results in

$$d_{ik}(p^N) + w^N \left[\partial_{p_i} d_{i,k}(p^N) \partial_{w_i} p_i^* + d_{ik}(p^N)\, 2\partial_{s_k} m_{i,k}(0)\, \mathrm{d}_{w_i} s_k^*(0)\right] = 0.$$

The assumption of quasi-concavity of $\pi_i(w_i)$ implies that the above condition characterizes the equilibrium wholesale price.

$$w^N = -\frac{d_{i,k}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^* + d_{i,k}(p^N)\, 2\partial_{s_k} m_{i,k}(0)\, \mathrm{d}_{w_i} s_k^*(0)}.$$

Substituting $\mathrm{d}_{w_i} s_i^*(0)$ from (5) delivers_

$$w^N = -\frac{d_{i,k}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) - d_{i,k}(p^N)\, 2\partial_{s_k} m_{i,k}(0)\, \frac{\partial_{s_k} m_{i,k}(0)}{2\partial_{(s_k)^2} m_{i,k}(0)} \left[\frac{(\partial_{w_i} p_i^*(w^N)-1)}{(p^N - w^N)} + \frac{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N)}{d_{i,k}(p^N)}\right]}.$$

Using definition (1) simplifies the above expression to

$$w^N = -\frac{d_{i,k}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) + d_{ik}(p^N)\, \lambda \left[\frac{(\partial_{w_i} p_i^*(w^N)-1)}{(p^N - w^N)} + \frac{\partial_{p_i} d_{ik}(p^N)\partial_{w_i} p_i^*(w^N)}{d_{i,k}(p^N)}\right]}.$$

Evaluating the retailer's FOC (3) of the sub-game at the equilibrium values of the complete game as above yields

$$p^N - w^N = -\frac{d_{i,k}(p^N)}{\partial_{p_{i,k}} d_{i,k}(p^N)}.$$

Substituting this margin into the previous expression for w^N results in

$$\begin{aligned}
w^N &= -\frac{d_{i,k}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) - d_{i,k}(p^N)\, \lambda \left[\frac{(\partial_{w_i} p_i^*(w^N)-1)}{-\frac{d_{i,k}(p^N)}{\partial_{p_{i,k}} d_{i,k}(p^N)}} + \frac{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N)}{d_{i,k}(p^N)}\right]} \\
&= -\frac{d_{ik}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) + \lambda \left[(1 - \partial_{w_i} p_i^*(w^N))\, \partial_{p_{i,k}} d_{i,k}(p^N) + \partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N)\right]} \\
&= -\frac{d_{ik}(p^N)}{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) + \lambda \left[\partial_{p_{i,k}} d_{i,k}(p^N) + \partial_{p_{i,-k}} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N)\right]}.
\end{aligned}$$

Retailers' margins for a product i decrease in w_i, i.e. $0 < \mathrm{d}_{w_i} p_i^* < 1$ as shown in Lemma 1. To see that $\partial_\lambda w^N < 0$, recall that the above is equivalent to $\partial_{w_i} \pi_i = 0$ evaluated at symmetric prices, i.e.

$$H \equiv w^N \left\{\partial_{p_i} d_{i,k}(p^N)\partial_{w_i} p_i^*(w^N) + \lambda \left[\partial_{p_{i,k}} d_{i,k}(p^N) + \partial_{p_{i,-k}} d_{i,k}(p^N))\partial_{w_i} p_i^*(w^N)\right]\right\} + d_{i,k}(p^N) = 0.$$

Applying implicit differentiation yields

$$\frac{\mathrm{d}w^N}{\mathrm{d}\lambda} = -\frac{\frac{\partial H}{\partial \lambda}}{\frac{\partial H}{\partial w_i} + \frac{\partial H}{\partial w_{-i}}}.$$

Note that the stability assumption (A8) requires that $\partial_{(w_i)^2} \pi_i(w^N, w^N) + \partial_{w_i w_{-i}} \pi_i(w^N, w^N) <$

0. Furthermore,

$$\frac{\partial H}{\partial \lambda} = w^N \left[\partial_{p_{i,k}} d_{i,k}(p^N) + \partial_{p_{i,-k}} d_{ik}(p^N))\partial_{w_i} p_i^*(w^N)\right] < 0.$$

Hence, $\partial_\lambda w^N < 0$.

$\square$

Lemma 3.

Proof. Given that using the additional instrument of RPM is a dominant strategy for a manufacturer i, she solves

$$\max_{w_i, p_i} \pi_i = w_i \sum_k d_{i,k}(p_i) M_{i,k}(s^*),$$

taking the prices of the other manufacturer as given. Recall that $d_{i,k}(p) \equiv d_{i,k}(p, p)$ and that $M_{i,k}(S^*) = 2m_{i,k}(s^*)$ by symmetry of the retailers service decisions in the subgame. The FOCs for a manufacturer using RPM can be written as

$$\begin{aligned} \partial_{w_i}\pi_i = d_i(p_i)\, m_{i,k}(s_k^*) + w_i d_i(p_i)\, \left(\partial_{s_k} m_{i,k}(s_k^*)\, \partial_{w_i} s_k^*\right) &= 0, \\ \partial_{p_i}\pi_i = w_i \left(\partial_{p_i} d_i(p_i)\, m_{i,k}(s_k^*) + d_i(p_i)\, \left(\partial_{s_k} m_{i,k}(s_k^*)\, \partial_{p_i} s_k^*\right)\right) &= 0. \end{aligned}$$

We proceed by showing that there exists a linear combination of the above conditions that equals the FOC for pricing under monopoly given by (2). Note that any linear combination of the above FOCs must be zero at the point of the optimal price. If there exists a linear combination of the above two FOCs that equals the FOC under monopoly, then the optimal price for a manufacturer using RPM equals the monopoly price.

Under RPM of manufacturer i, the following derivatives can be derived from the FOC of a retailer wrt. service analogously to the proceeding in Lemma (2):

$$\begin{aligned} \frac{\mathrm{d}s_k^*}{\mathrm{d}p_i} &= \frac{-\partial_{s_k} m_{i,k}(s_k)\, \left[d_{ik}(p_i) + (p_i - w_i)\, \partial_{p_i} d_{ik}(p_i)\right]}{\partial_{(s_k)^2} m_{i,k}(s_k)\, (p_i - w_i) d_{i,k}(p_i) + \partial_{(s_i)^2} m_{i,k}(-s_k)\, (p_{-i} - w_{-i})\, d_{-i,k}(p_{-i})}, \\ \frac{\mathrm{d}s_k^*}{\mathrm{d}w_i} &= \frac{\partial_{s_k} m_{i,k}(s_k)\, d_{i,k}(p_i)}{\partial_{(s_k)^2} m_{i,k}(s_k)\, (p_i - w_i) d_{i,k}(p_i) + \partial_{(s_i)^2} m_{i,k}(-s_k)\, (p_{-i} - w_{-i})\, d_{-i,k}(p_{-i})}. \end{aligned}$$

Substituting these into the two manufacturer's FOCs above and using that $\partial_{w_i}\pi_i + k\, \partial_{p_i}\pi_i = 0\, \forall k$, it can be shown that $k = p_i / w_i$ implies $p_i\, \partial_{p_{i,k}} d_{i,k}(p_i) + d_{i,k}(p_i) = 0$ which is true iff $p_i = p^M$. $\square$

Proposition 2.

Proof. Summing up the FOCs of a manufacturer's maximization problem, imposing symmetry and using the normalization $m_{i,k}(0) = 0.5$ implies $w^R \partial_{p_i} d_{i,k}(p^M, p^M)\,(1+\lambda) + d_{i,k}(p^M, p^M) = 0$. Rearranging yields

$$w^R = \frac{d_{i,k}(p^M, p^M)}{-\partial_{p_i} d_{i,k}(p^M, p^M) \cdot (1+\lambda)} = \frac{p^M}{1+\lambda}.$$

As $p^R = p^M$ for any retailers' potential to shift demand, λ, the wholesale price clearly decreases in λ. For $\lambda \to \infty$, $w^R \to 0$ and for $\lambda \to 0$, $w^R \to p^M$. □

Lemma 4.

Proof. Note that due the single peakedness of the retailer's profit in $p_{i,k}$ (this follows from demand assumption (A4)) the first derivative is monotone in $p_{i,k}$, hence if the first derivative of the profit function wrt. to $p_{i,k}$ is positive at $p_{i,k} = p^M$, retailer k wants to increase (decrease) price and hence RPM acts as maximum (minimum) RPM, i.e. for minimum RPM:

$$\partial_{p_{i,k}} d_{i,k}(p^M, p^M)\,(p^M - w^R) + d_{i,k}(p^M, p^M) < 0.$$

Substituting $w^R = p^M/(1+\lambda)$ and $p^M = -\frac{d_{i,k}(p^M, p^M)}{\partial_{p_i} d_{i,k}(p^M, p^M)}$ in the above yields

$$-\partial_{p_{i,k}} d_{i,k}(p^M, p^M)\,\frac{d_{i,k}(p^M, p^M)}{\partial_{p_i} d_{i,k}(p^M, p^M)}\,(1 - \frac{1}{1+\lambda}) + d_{i,k}(p^M, p^M) < 0.$$

Rearranging results in

$$\frac{-\partial_{p_{i,k}} d_{i,k}(p^M, p^M)}{\partial_{p_i} d_{i,k}(p^M, p^M)}\,(\frac{\lambda}{1+\lambda}) < -1.$$

and, equivalently,

$$\frac{\partial_{p_{i,k}} d_{i,k}(p^M, p^M)}{-\partial_{p_{i,-k}} d_{i,k}(p^M, p^M)} - 1 < \lambda.$$

□

Lemma 5.

Proof. For notational convenience subscript i is suppressed. Recall that $d_{i,k}(p) \equiv d_{i,k}(p, p)$. Define $\phi(p) \equiv \frac{d_k(p)}{-\partial_p d_k(p)}$ with $p_1 = p_2 = p$. Log-concavity of $d_k(p)$ implies that $\partial_p \phi(p) \leq 0$. Hence $p^N < p^M$ implies that $\phi(p^N) \geq \phi(p^M)$. Note that $p^M = \phi(p^M)$.

The condition $p^N < p^M$ can be rewritten as $(p^N - w^N) + w^N < p^M$. Substituting from8 and 7 yields

$$(p^N - w^N) + w^N = -\frac{d_k(p^N)}{\partial_{p_k} d_k(p^N)} - \frac{d_k^N(p^N)}{\partial_{p_{-k}} d(p^N)\,\partial_w p^*(w^N)\,(1+\lambda)\,+\partial_{p_k} d_k(p^N)\,(\partial_w p(w^N)+\lambda)}$$

and rearanging 2 and subtituting yields

$$-\frac{d_k(p^N)}{\partial_{p_k} d_k(p^N)} - \frac{d_k^N(p^N)}{\partial_{p_{-k}} d(p^N)\,\partial_w p^*(w^N)\,(1+\lambda)\,+\partial_{p_k} d_k(p^N)\,(\partial_w p(w^N)+\lambda)} < -\frac{d_k(p^M)}{\partial_p d_k(p^M)}.$$

Hence $p^N < p^M$ implies that $\phi(p^N) \geq \phi(p^M) > (p^N - w^N) + w^N$ and consequently

$$\phi(p^N) = \frac{d_k(p^N)}{-\partial_p d_k(p^N)} > -\frac{d_k(p^N)}{\partial_{p_k} d_k(p^N)} - \frac{d_k(p^N)}{\partial_{p_{-k}} d(p^N)\,\partial_w p^*(w^N)\,(1+\lambda)\,+\partial_{p_k} d^N\,(\partial_w p(w^N)+\lambda)}$$

Rearranging yields

$$\lambda \;\; > \;\; \frac{\frac{-\partial_{p_k} d_k(p^N)}{\partial_{p_{-k}} d_k(p^N)} - \partial_w p^*(w^N)}{\frac{\partial_{p_{-k}} d(p^N)\,\partial_w p^*(w^N)+\partial_{p_k} d^N}{\partial_p d_k(p^N)}}.$$

This expression simplifies to

$$\lambda > \frac{-\partial_{p_k} d_k(p^N)}{\partial_{p_{-k}} d_k(p^N)} - 1.$$

with $\frac{\left[\partial_{p_k} d_k(p^N)+\partial_{p_{-k}} d_k(p^N)\partial_w p^*(w^N)\right]}{\partial_p d_k(p^N)} \geq 1$. This condition approaches $\lambda > 0$ as retailing competition approaches Bertrand, i.e. $\partial_w p^* \to 1$ and $\frac{-\partial_{p_k} d_k(p^N)}{\partial_{p_{-k}} d_k(p^N)} \to 1$. Similarly, as the RHS is bounded for $\partial_{p_{-k}} d_k(p) > 0 \forall p \geq 0$, as λ grows without bounds, the condition holds for sufficiently high λ.

□

Proposition 3.

Proof. Recall that $p^R = p^M$ is independent of λ, but $\partial_\lambda p^N > 0$ as $\partial_\lambda w^N > 0$ by Proposition 1 and $\partial_{w_i} p_i^* > 0$ by Lemma 1. Let denote λ^M denote the λ that solves $p^M = p^N(\lambda^M)$. Note that it must be that

$\lambda^M = \frac{-\partial_{p_k} d_k(p^N)}{\partial_{p_{-k}} d_k(p^N)}$ by construction of condition (11). Furthermore, at $p^N = p^M$, the RHSs of conditions (10) and (11) coincide. Hence, there is effectively neither minimum nor maximum RPM at $p^N = p^M$. This implies that $w^N = w^R$ (see Lemma 4). Clearly, $d_{i,k}(p^N) = d_{i,k}(p^M)$ and hence, there is no dilemma as $w^R d(p^R) = w^N d(p^N)$.

Consider an increase of λ^M by ϵ. The RHS of the minimum RPM condition (12) is not a function of λ and hence $\lambda^M + \epsilon >$, i.e. for all $\lambda > \lambda^M$, there is minimum RPM and for all $\lambda < \lambda^M$, there is maximum RPM. The RHS of condition (11) is a function of λ. However, p^N is affected by λ only through the wholesale price, in particular $\partial_{w_N} p^N > 0$ by Lemma 1. The wholesale price decreases monotonically in λ, i.e. $\partial_\lambda w^N < 0$ by Proposition 1. Hence, for all $\lambda \gtreqless \lambda^M$, it must be that $p^M \gtreqless p^N$.

In consequence, the conditions for minimum RPM and a price increase due to RPM are equivalent. □

Lemma 6.

Proof. Consider that the conditions for minimum RPM 10 and a price increase 11 they only differ by the price locus of the partial derivatives with respect to prices. However, as these derivatives are constants under linearity they are independent of the price level and hence both expressions are equivalent. For the comparison of the wholesale prices WLOG define d_{ik} as $a - bp_{ik} + cp_{i,-k}$ with $a = \frac{\alpha}{\beta+\gamma}$, $b = \frac{\beta}{\beta^2-\gamma^2}$ and $c = \frac{\gamma}{\beta^2-\gamma^2}$. Recall that by Lemma1, the price $p^*(w)$ is characterized by the FOC (3)of retailer's profit with respect to p_k under symmetry, i.e. $p_1 = p_2$. With linear demand, this corresponds to

$$a - b\,p + c\,p + (p - w)(-b) \quad = \quad 0$$

and hence

$$p^*(w) = \frac{a + w\,b}{2b - c}.$$

Equilibrium prices for the symmetric cases with and without RPM can be easily obtained by plugging the linear-demand analogs into the reduced form expressions (2), (7), (8), and (9). Note that for the linear demand case, $\partial_{p_{-k}} d_{i,k}(p_i^N) = c$, $\partial_{w_i} p_i^* = \frac{b}{2b-c}$, $\partial_{p_{i,k}} d_{i,k}(p_i^N) = -b$, $\partial_{p_i} d_i(p_i^N) = 2(-(b-c))$, $d_{ik}(p_i^N) = a - (b-c)\,\frac{a+w\,b}{2b-c}$. Let the subscript $_{LIN}$ denote equilibrium prices of the linear demand case. This yields

$$w_{LIN}^N = \frac{a}{2(b-c)(1+\lambda)},$$

$$p_{LIN}^N = \frac{a + w^N\,b}{2b - c} = \frac{a}{2b-c}(1 + \frac{b}{2(b-c)(1+\lambda)})$$

$$p_{LIN}^R = p_{LIN}^M = \frac{a}{2(b-c)}.$$

$$w_{LIN}^R = \frac{p_{LIN}^M}{1+\lambda} = \frac{a}{2(b-c)(1+\lambda)}$$

Note that $w_{LIN}^N = w_{LIN}^R$, i.e. the wholesale price does not depend on the regime (RPM or no

RPM). Hence, the dilemma condition $w^N d(p^N) > w^R d(p^M)$ reduces to $d(p^N) > d(p^M)$ which is true if and only if $p^N < p^M$ as $\partial_p d(p) = -\frac{1}{\beta+\gamma} < 0$. $\square$

Appendix B: Micro foundation of service

In this extension, we motivate the assumptions imposed on reduced-form demand in equation (1) by modeling retailers as matchmakers. After retail prices are set, assume that the game proceeds as follows:

1. Consumers are not informed about the existence nor the match value of the two products and hence randomly visit a retailer.
2. Each retailer receives a signal for each consumer in his shop and matches one product $i \in \{A, B\}$ to each consumer.
3. Each consumer learns her valuation $v_{i,k}$ for the matched product i at both retailers k, and learns the prices P_i for this product at both retailers
4. Each consumer decides to buy one unit of the matched product at one retailer or buy nothing at all.

There is a mass Γ of consumers. A consumer is of type $\omega \in \{A, B\}$ with $Pr(\omega = A) = 0.5$. While the distribution is common knowledge, an individual consumer's type and her valuations are ex ante unknown to everybody. As consumers ex ante do not know their product or retailer preferences we assume that they distribute symmetrically over both retailers.

Once a consumer seeks advice at a retailer, the retailer receives a private and noisy signal σ about the consumer's type that is distributed with the cdf $F(\sigma)$ of the interval $[\underline{\sigma}, \bar{\sigma}]$. With the information of the signal he updates his beliefs about the consumer type $q(\sigma) = Pr(\omega = A|\sigma) = 1 - Pr(\omega = B|\sigma)$. Both retailers receive the same signal for each consumer, which is commonly known. Hence, both retailers have the same posterior belief about any consumer's type.[38]

A consumer with type ω c.p. prefers product $i = \omega$ over $i \neq \omega$. Assume that a consumer of type ω being matched with product $i = \omega$ draws her valuation $v_{i,k}$for each retailer from the joint distribution $H(v_{i,k}, v_{i,-k})$. Instead, if the consumer is matched with product $i \neq \omega$, she draws a valuation of 0 with probability 1. This simplifies the presentation of a consumer's inference as a mis-match simply has a value of 0 to the consumer.

[38]This simplifies the analysis as a consumer correctly infers that retailers in the symmetric equilibrium treat her equally, hence visiting the other retailer for another advice does not occur.

What happens if a consumer realizes $v_{i,k} = 0$? In reality, the consumer may ask for the other product to be presented to her. In order for advice to be important, it must be that in equilibrium not all consumers are completely informed about all products. Allowing for a consumer to desire a second advice in some cases would complicate the model. Therefore, we assume that no consumer considers a second match. This is reasonable if the net value of a second demonstration is negative. Toward this goal, one may assume that the cost of time per consumer advice is sufficiently convex.[39] Alternatively, one may assume that independent of ω, there is a mass point of $\delta \equiv Pr(v_{i,k} = 0) > 0$. A consumer realizing $v_{i,k} = 0$ for this first match correctly infers that either she does not like any of the products or that this match was a mis-match, i.e. $\omega \neq i$ and $v_{-i,k} > 0$. If retailers provide informative advice and δ is not too small, the first match has a higher expected match value than the second match. Hence, even with linear costs of time, a consumer may rationally stop searching after a first unsuccessful advice.

For consumers to rationally seek advice, matching quality must be sufficiently high in equilibrium. If a retailer biases his advice, matching quality declines. For the following exposition, assume that consumers believe that retailers' advice is sufficiently good and that this belief is fulfilled in equilibrium, i.e. advice is indeed not too biased. We abstract form modeling this belief explicitly.

A consumer buys at retailer k iff $v_{i,k} - p_{i,k} \geq \max(v_{i,-k} - p_{i,-k}, 0)$. Integrating this condition over $v_{i,k}, v_{i-k}$ yields the probability of a sale conditional on a correct match. This is given by

$$d_{i,k}(P_i) = \int_{p_{i,k}}^{\infty} \int_{-\infty}^{v_i - p_{i,k} + p_{i,-k}} h(v_{i,k}, v_{i-k}) dv_{i,-k} dv_{i,k}.$$

This demand formulation has the property that demand decreases when all prices increase, with $\partial_{p_{i,k}} d_{i,k} < 0$ and $\partial_{p_{i,-k}} d_{i,k} > 0$ if h does not vanish. However, this discrete choice demand foundation is generically inconsistent with globally linear price derivatives, for a more detailed discussion see Jaffe and Weyl (2010). Our assumptions on higher order derivatives, in particular, the negative dominant diagonal of the Hessian of $d_{i,k}$ can be met by choosing an appropriate distribution H.

The service choice of a retailer boils down to choosing a threshold probability s_k, such that for signals above s_k, the retailer matches consumers with product A and for smaller σ with product B. The mass of consumers who are correctly matched with product i, by retailer k, is given by

$$\begin{aligned} m_{A,k}(s_k) &= \int_{\underline{\sigma}}^{s_k} q(\sigma) dF(\sigma), \\ m_{B,k}(s_k) &= \int_{s_k}^{\bar{\sigma}} 1 - q(\sigma)\, dF(\sigma) \end{aligned}$$

[39] For example, Ellison & Wolitzky (2009) use this assumption.

The total mass of consumers relevant for product i consists of the sum of the consumers correctly matched with i at each retailer, i.e. $M_i = m_{i,k}(s_k) + m_{i,k}(s_{-k})$.

Differentiating $m_{A,k}$ (analogously $m_{B,k}$) with respect to s_k yields

$$\begin{aligned} \partial_{s_k} m_{A,k} &= -q(s_k) f(s_k), \\ \partial_{(s_k)^2} m_{A,k} &= -(q' f + f' q). \end{aligned}$$

If σ is uniformly distributed which implies $f'(\sigma) = 0$, the second derivatives of $m_{A,k}$ and $m_{B,k}$ are negative on the support of σ and, hence, M_i is concave in S. For example, consider $\Gamma = 4/3$, σ is uniformly distributed on the interval $[-0.5, 0.5]$, and $1 - q(\sigma) = (\sigma + 0.5)$. This yields $m_{A,k} = {}^4\!/_6(1 - (-s_k + 0.5)^2)$, which meets our required properties.

Finally, demand for product i at retailer k as a function of prices P_i and service decisions S is given by

$$D_{i,k}(P_i, S) = d_{i,k}(P_i)\, M_i(S).$$

This corresponds to the reduced form of demand in equation (1).

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