Branding, Quality, and "Price Ownership" through RPM*

Roman Inderst† Sebastian Pfeil‡

November 2013 [Preliminary]

Abstract

Manufacturers constantly make decisions that affect product quality, e.g., through procuring high-quality inputs or maintaining high hygienic standards in production. We show first how a high price for its product increases a manufacturer's incentives, so that there is a positive relationship between quality and price. We then show how this gives rise to a conflict of interest between retailers and the manufacturer in the choice of the final price. Retailers do not internalize the reputation spill-over that higher prices have on demand at all outlets and they have, in addition, less incentives to support brand image through higher prices as this erodes their own outside option in negotiations while increasing that of the manufacturer. "Price ownership" by the manufacturer, as supported by RPM, can then lead to higher quality and potentially higher overall efficiency.

*We thank seminar participants and discussants at the University of Mannheim/ZEW and at DICE/Düsseldorf for helpful comments. Inderst gratefully acknowledgs financial support from the Leibnitz grant of the German Science Foundation (DFG). Part of this research is used in the policy report "Price ownership by brand manufacturers", funded by Markenverband.

†University of Frankfurt and Imperial College London. E-mail: inderst@finance.uni-frankfurt.de.

‡University of Frankfurt.

1 Introduction

Consumers must trust manufacturers to constantly strive to uphold high quality, e.g., through procuring high-quality inputs, satisfying strict hygienic and food-safety standards, and exercising overall care when handling the good in production and distribution. Consumers often rely on brands as certifiers of high quality. And higher prices are often associated with high brand image (cf. also the literature discussion below). In this paper, we explore this link between pricing and quality assurance and ask, in particular, to what extent retail price maintenance (RPM) as a way to give manufacturers "price ownership" may be conducive to guarantee an efficient provision of quality.

For many fast-moving consumer goods, notably in food retailing, quality depends on a manufacturer's continuously made decisions to, for instance, to procure high-quality inputs or to secure high hygienic standards in production and handling. We show how, in this model, higher prices are associated with a higher provision of quality and we analyze how this relationship is affected by key parameters such as the likelihood with which consumers observe quality (rather than relying only on their rational beliefs). We then show that retailers may have insufficient incentives to choose a price that is conducive to high quality, as they do not fully internalize the reputation spill-over that this has for the provision of the manufacturer's good and as they care more about their own and less about the manufacturer's bargaining position, which is affected by consumers' perception about the product's (brand) quality. Overall, efficiency can thus be higher when manufactures can exert (more) control also over retail prices.

Our theory is different from most of the extant theory of RPM that relies on moral hazard, as there it is typically the retailer who must perform some non-contractible action, such as to keep inventories (Deneckere et al. 1997) or provide services and other demand-enhancing activities (e.g., Telser 1960; Klein and Murphy 1988; Mathewson and Winter 1998; see, however, Romano 1994 for a setting where both parties make a non-price decision affecting demand).[1] In many instances, that have been emphasized in the economic literature, retailers may also not provide the type of services, such as advice. Instead, for many branded products in areas such as grocery or cosmetics it may be manufacturers who must be incentivized to constantly ensure high quality, in which case the underly-

[1] When there is moral hazard and free-riding by retailers, the manufacturer may be able to resort to the threat of delisting so as to induce certain actions. In the US, this is often referred to as the "*Colgate* doctrine", which affords manufacturers the option to sell only to vendors whose retail prices adhere to a suggested (rather than contractually stipulated) retail price (cf. section III in Elzinga and Mills 2008). Such an alternative is, however, not possible when it is the supplier who must be incentivized.

ing opportunism problem lies between manufacturers and consumers. In fact, through the timing of strategies in our model, as we discuss below, we can fully abstract from manufacturer opportunism problems vis-à-vis retailers, so that, in particular, RPM is not needed to mitigate intrabrand competition.[2] Taken together, one of our contributions is thus to provide a rationale for why branded goods manufacturers may be particularly eager to keep control over the retail price, even when retailers need not be incentivized to provide services such as advice and even when intrabrand competition is not the main concern. The reason, in our model, is the link between price and quality (perception) together with a conflict of interest between retailers and the manufacturer with regards to the optimal choice of quality.

In our model, a higher price will be associated with higher quality (and higher perception of quality by those consumers who do not directly observe quality choice). When the manufacturer controls the retail price, he will internalize the benefits from an overall higher perception of quality. Precisely, when consumers form beliefs based on their perception of prices across all retailers and shopping trips, the manufacturer internalizes this. In contrast, when retailers have "price ownership", they tend to free-ride, instead. That is, even when they are not in direct competition for an individual consumer, e.g., as the consumer always buys the respective product at the most convenient outlet at any given time, retailers have an incentive to choose a strictly lower retail price than preferred by the manufacturer. We derive conditions for when efficiency is higher in the latter case, as the induced increase in quality dominates deadweight loss from a higher price.

A second channel through which such a difference in interests between manufacturers and retailers affects prices and quality is the effect that the product's (perceived) quality has on the outside options of manufacturers and retailers. Retailers may set a lower price, also so as to thereby induce lower quality perceptions in order to decrease the outside option of the manufacturer and enhance their own outside option in case they later stock a different product. Notably, under our chosen bargaining solution, such a conflict of interest would not arise when quality was exogenous, as then retailers and the manufacturer would choose the same price. Hence, the fact that quality matters to consumers and that it is endogenous is essential also for this potential conflict of interest to arise in our model. Again it follows that quality is higher when the manufacturer controls the price.

In our baseline model, a higher price induces higher quality when this choice is observed

[2] In practice, repeated interaction and the transparency of retail prices may indeed curb such opportunism.

by at least some consumers (or when it is observed at least with positive probability by any given consumer). All other consumers form rational expectations based on this relationship and the observed price. Albeit with a different timing, in Wolinsky (1983) firms first decide on unobserved quality and then use high prices as a signal. Similarly, also in Shapiro (1982) or Klein and Leffler (1981) lower quality leads to a subsequent reduction in sales.[3] The notion that higher prices are associated with higher perceived quality of a product or brand is furthermore frequently encountered in the marketing literature.[4] Finally, to model negotiations between a manufacturer and several, possibly competing retailers in a way that allows to incorporate much information about retailers' and the manufacturer's outside options, we use at this stage of the game an axiomatic bargaining approach. For this we propose an extension of the idea in Inderst and Wey (2013), where each bilateral contract provides "fair" sharing rules (as in Myerson 1977) contingent on whether other supply relationships are concluded or not. As we will discuss, the obtained solution is closely related to other recent solution concepts to multilateral negotiations, in particular Navarro (2007) and De Fontenay and Gans (2013).

The rest of this paper is organized as follows. Section 2 introduces the baseline model and establishes a relationship between price and quality. Section 3 introduces retailers and with them our model of negotiations. Section 4 considers non-competing retailers to isolate a conflict of interest that arises from free-riding on brand (quality) image by individual retailers. In Section 5 we introduce retailer competition and analyze how this affects retailers' and manufacturer's incentives to induce different quality provision through the choice of the retail price. Section 6 offers some concluding remarks.

2 The Relationship Between Price and Quality

2.1 Model

In this section we consider the following auxiliary model to introduce the basic relationship between price and quality. There is a monopolistic manufacturer who sells a single product directly to final consumers. That is, we presently fully abstract from the presence of an intermediary.

[3] Also in models where quality is exogenously given, high-quality firms may use high prices to signal the superiority of their products (e.g., Bagwell and Riordan 1991 or Milgrom and Roberts 1986, where high prices are used in combination with dissipative advertising).

[4] Cf. Leavitt (1954) or Rao and Monroe (1989).

Demand. Demand depends on the product's price p and a scalar indicator of quality $q \geq 0$: $D(p,q)$. The supplier's costs depend on quantity $x = D(p,q)$ and quality: $c(x,q)$. As we will discuss in what follows, the positive relationship between price and quality that we derive in this section holds generally whenever $c_{qx} \geq 0$, i.e., when per-unit costs of production are weakly increasing in quality.[5] Our motivational examples in the introduction suggest however a specification where costs of ensuring higher quality change proportional with quantity: $c(x,q) = k(q)\,x$. For instance, this should be the case when higher costs result from the procurement of higher-quality inputs or from ensuring higher hygienic and safety standards in production and shipment. Here, $k(q)$ is assumed to be a twice differentiable function with $k'(q) > 0$ for $q > 0$ and $k''(q) \geq 0$.

The supplier's profits are

$$\Pi = D(p,q)\,[p - k(q)]$$

and consumer surplus equals

$$CS = \int_p^\infty D(v,q)dv.$$

We further specify that $D_p < 0$ and $D_q > 0$ where $D > 0$.

For further illustrations it is helpful to introduce already now two particular well-known specifications of demand. Our first specification is that of linear demand,

$$D(p,q) = q - p,$$

where for convenience only we have set the slope equal to one and the intercept equal to quality q. This could be derived from the linear-quadratic utility of a representative consumer, $qx - \frac{1}{2}x^2$, in which case it is this consumer who will later be either informed or uninformed about quality. Alternatively, demand could be obtained from the aggregation of a continuum of consumers, indexed by y, where an individual consumer derives the utility $y + q$. When y is uniformly distributed, this obtains a linear demand function.[6] Later we will also relate to the case where consumers' (marginal) valuation for quality differs, in particular where the respective utility is qy, so that those with a higher absolute valuation also have a higher marginal valuation for quality.[7]

[5] This is however not a necessary but only a sufficient condition.

[6] More formally, $y \in [y_l, y_h]$ would be distributed according to $F(y)$, where the latter is uniform with $F(y) = (y - y_l)/(y_h - y_l)$. Demand is equal to $D(p,q) = 1 - F(\widetilde{y})$, where the critical type solves $\widetilde{y} = p - q$. The choice of y_l and y_h determines intercept and slope of the linear demand function.

[7] Then, the critical type is $\widetilde{y} = p/q$, so that with distribution $F(y)$ demand is $D(p,q) = 1 - F(\widetilde{y})$.

Strategies and Timing. For the present auxiliary analysis, we now consider the following game. First, in $t = 1$, the firm chooses a price p. Then, in $t = 2$, it chooses a quality q. Finally, in $t = 3$, consumers decide whether to purchase or not. We discuss the sequence of timing in $t = 1$ and $t = 2$ below. Further, before purchasing a consumer only observes with probability γ the true quality. As we restrict consideration to equilibria in pure strategy (which, however, will be without loss of generality given our assumptions on the profit function), we denote an uninformed consumer's beliefs by $\widehat{q}$. These will depend on the observed price choice.

Before analyzing this game, we comment on the choice of the sequence of timing in $t = 1$ and $t = 2$. Our focus in this paper is on price as a long-term choice ("price image"). It is part of the overall positioning of the product, i.e., its branding. The decision on the overall price level must then be complementary to the other marketing choices such as the scope and content of the advertising campaign. While surely some key (quality) features of the product are also chosen for the long term, with a view particularly on fast moving consumer goods and, most notably, branded grocery products, we consider decisions that must be made constantly so as to maintain high quality. As mentioned previously, this could concern the procurement of high-quality inputs or the overall conditions of production and handling of the product (e.g., with regards to food safety). Here, the firm could be tempted to save costs by reducing care or, more particularly, selecting cheaper inputs.

While we thus consider the timing of our presently analyzed game to be particularly suitable for the purpose of our analysis, we should note, however, that our results do not necessarily depend on it. Instead, consider for a moment the case where quality was chosen before price. As we discuss below, when all consumers are informed about quality, the equilibrium outcome would be the same, as the choice of both price and quality solves the respective first-order condition in either case. Suppose next that with positive probability consumers do not observe quality. Then, when the timing is reversed, we face a (signaling) game of private information where, however, the choice of "type" (quality) is endogenous. We conjecture that the qualitative insights of our results in this section would extend under a suitable choice of refinement.[8]

[8] See, more generally, for an analysis of such games In and Wright (2012). For an entirely different application, Inderst and Pfeil (2013) show how the equilibrium is independent of the sequence of timing when one applies a Forward Induction Refinement for the case where the "type" is chosen first.

2.2 Equilibrium of the Auxiliary Game

Demand. We solve the game backwards. Consumers' decision in $t = 3$ is already captured by the demand function. Note here, however, that a given consumer is only informed with probability γ about the true quality choice. With probability $1 - \gamma$ a consumer is uninformed and has the beliefs $\widehat{q}$. Demand is thus given by

$$\widehat{x} = \gamma D(p, q) + (1 - \gamma) D(p, \widehat{q}),$$

so that firm profits are

$$\Pi(p, q, \widehat{q}) = \widehat{x}\left[p - k(q)\right], \tag{1}$$

depending on price, actual quality, and quality beliefs.

Quality Choice in $t = 2$. Turn now to $t = 2$, where the firm chooses its optimal quality level. Note that this affects demand only when the consumer is subsequently informed about quality. For given beliefs $\widehat{q}$, the optimal quality q_{BR} is thus determined from (1) by the following first order condition:

$$\left.\frac{d}{dq}\Pi\left(p, q, \widehat{q}\right)\right|_{q=q_{BR}} = \gamma\left[p - k(q_{BR})\right] D_q\left(p, q_{BR}\right) - \widehat{x}_{BR} k'\left(q_{BR}\right) = 0, \tag{2}$$

where we used $\widehat{x}_{BR} = \gamma D(p, q_{BR}) + (1 - \gamma) D(p, \widehat{q})$. We assume that Π is strictly quasiconcave in q so that there is always a unique value q_{BR}. (Here, the notation q_{BR} refers to the fact this is the "best response" to a particular choice of the price and consumers' beliefs.)

In equilibrium, given the price p that is set initially and that is observed by all consumers, beliefs must be rational. In a slight extension of notation, it is thus required that $\widehat{q} = q_{BR}(\widehat{q})$ (where it is convenient to suppress for now the dependency on the price). We denote this level, for given p, by $\widehat{q}^*$. Using the condition for q_{BR} from (2), $\widehat{q}^*$ must solve

$$z(p, \widehat{q}^*) := \gamma\left[p - k\left(\widehat{q}^*\right)\right] D_q\left(p, \widehat{q}^*\right) - D(p, \widehat{q}^*) k'\left(\widehat{q}^*\right) = 0. \tag{3}$$

Again, we assume that this gives rise to a unique interior solution.

From implicit differentiation of (2), we have

$$\frac{d\widehat{q}^*}{dp} = \frac{1}{-z_{\widehat{q}^*}}\left[\begin{array}{c} \gamma D_q(p, \widehat{q}^*) \\ -k'(\widehat{q}^*) D_p(p, \widehat{q}^*) \\ +\gamma\left(p - k(\widehat{q}^*)\right) D_{pq}(p, \widehat{q}^*) \end{array}\right], \tag{4}$$

where we have already split-up the three terms that we discuss below in turn. Note first that $z_{\widehat{q}^*} < 0$.[9] Hence, the sign of $d\widehat{q}^*/dp$ is then determined by the expression in rectangular

[9] Precisely, this follows from inspection of the second-order derivative of firm profits, i.e., from differentiation of the first-order condition (2), and noting that $D_q > 0$ and $k' > 0$. (Note also that in the more general case with costs $c(x, q)$, this holds as long as $c_{xx} > 0$ and $c_{qx} \geq 0$.)

brackets in (4). This expression comprises three different effects that the price level has on quality. We discuss these effects next.

The first line of this term in (4) is strictly positive. When the price and thus also the margin is higher, the firm has more to gain by sustaining demand through choosing a higher quality. This is the most immediate effect that a higher price has on the manufacturer's incentives to maintain quality at a high level. The strength of this effect hinges on the likelihood with which quality is observed (or, likewise, on the respective fraction of informed consumers). Interestingly, as we work out below, it is this direct effect, however, that also ensures that a higher price will serve as a credible signal of higher quality for those consumers who do not observe quality.

The second line in (4) is also strictly positive from $D_p < 0$ and $k' > 0$.[10] As the price increases and demand thereby decreases, an increase in the per-unit costs, when this is associated with higher quality, has a smaller negative impact on overall firm profits. This effect is independent of the observability of quality.

We turn next to the last effect, as captured by the final line in (4). This term is zero when the marginal utility of an increase in quality is independent of the level of a consumer's valuation. This holds, for instance, when demand is linear and separable in p and q as in our previous specification with a continuum of consumers and additive utility, $q + y$, as well as with a representative consumer and quadratic utility. But the effect is strictly positive when, as also introduced above, there is a continuum of consumers, indexed by y, with respective utility qy. In this case, a higher price amplifies the negative impact that a lower quality has on demand. This follows, in turn, as the higher price pushes up the critical type $\widetilde{y}$, who in this case, i.e., when $u(y) = qy$, has a strictly higher marginal valuation for quality. Consequently, at a higher price demand is now also more responsive to a change of quality.

In what follows, we always stipulate that $D_{pq} \geq 0$, so that altogether - from the three discussed effects - a higher price will strictly increase the firm's incentives to maintain high quality.

Lemma 1 *When $D_{pq} \geq 0$ holds at least weakly, then at stage $t = 2$ in the auxiliary model quality, as obtained in (3), strictly increases with price: $d\widehat{q}^*/dp > 0$.*

For given p, the resulting quality $\widehat{q}^*$ (as obtained in Lemma 1) is inefficiently low. To see this most immediately, take the case where $\gamma = 1$. When all consumers observe quality,

[10] This effect would be absent when, with general cost of production $c(x, q)$, we had $c_{qx} = 0$, so that costs of quality provision were independent of actual output.

it is determined by the manufacturer's first-order condition, as given - now with $\widehat{q} = q_{BR}$ - by (2). This, however, ignores the impact on consumer surplus. The marginal impact of an increase in quality is, in this case, simply $\int_p^\infty D_q(v, q_{BR})dv > 0$. When $\gamma < 1$, then for given price p the respective quality is still (inefficiently) lower.[11]

Illustration of Quality Choice. For an illustration, take the constant marginal cost of production $\frac{1}{2}\frac{1}{k}q^2$. When we stipulate a uniform distribution for consumer types y (with upper boundary y_h), together with the additive utility $y+q$, then after some transformations condition (3) becomes

$$\gamma\left(2kp - (\widehat{q}^*)^2\right) = 2\widehat{q}^*\left(y_h + \widehat{q}^* - p\right),$$

from which we obtain by implicit differentiation

$$\frac{d\widehat{q}^*}{dp} = \frac{\gamma k + \widehat{q}^*}{(2+\gamma)\,\widehat{q}^* + y_h - p}.$$

The reaction of the resulting equilibrium quality on the price depends intuitively both on the marginal cost of quality provision and on the fraction of informed consumers, γ. We can also solve explicitly for

$$\widehat{q}^* = \frac{p - y_h + \sqrt{(p-y_h)^2 + 2p\gamma\,(2+\gamma)\,k}}{2+\gamma},$$

which yields, in particular, $\widehat{q}^* = p$ when $\gamma = 0$. We will return to these derivations below when solving for the full game in the presence of intermediaries.[12]

Equilibrium Price Level. To determine the optimal price level that the manufacturer chooses in $t = 1$, it is instructive to first consider the case where $\gamma = 1$, in which case all consumers can observe quality. Note first that then $\widehat{q}^*$, which is determined in (3), also solves the first-order condition (2). Turning to $t = 1$, from the envelope theorem we can thus conclude that the optimal price p is then determined simply by setting the respective partial derivative with respect to p equal to zero. This is, however, no longer the case when

[11] Note that this holds irrespective of the choice of demand function. When instead price can flexibly respond to a change in quality, Spence (1975) has shown that efficiency depends on whether the marginal benefits from an increase in quality differ between the marginal and the average (inframarginal) consumer who buys.

[12] In case of multiplicative utility, with now $u(y,q) = yq$, albeit we can then no longer characterize $\widehat{q}^*$ explicitly, we obtain

$$\frac{d\widehat{q}^*}{dp} = \frac{\widehat{q}^*\left(4\gamma kp + (2-\gamma)\widehat{q}^{*2}\right)}{2\gamma kp^2 - (2-\gamma)p\widehat{q}^{*2} + 4y_h\widehat{q}^{*3}} > 0.$$

$\gamma < 1$. Then, for a given price, the resulting equilibrium quality $\widehat{q}^*$ will be strictly below the value that would maximize ex-ante firm profits. The firm thus has a commitment problem vis-à-vis consumers. Formally, this implies that the envelope theorem then no longer applies for the derivation of the optimal price p, which now takes into account the subsequent adjustment of quality, $d\widehat{q}^*/dp$.

Precisely, making use of the expression $\Pi\left(p, q_{BR}, \widehat{q}\right)$ for profits, now with $q_{BR} = \widehat{q} = \widehat{q}^*$ so that q_{BR} solves the first-order condition (2), the optimal price p in $t = 1$ solves

$$\begin{aligned} \frac{d\Pi(p, \widehat{q}^*, \widehat{q}^*)}{dp} &= \left[p - k\left(\widehat{q}^*\right)\right] D_p(p, \widehat{q}^*) + D(p, \widehat{q}^*) \\ &\quad + \frac{d\widehat{q}^*}{dp}\left[D_q(p, \widehat{q}^*)\left(p - k\left(\widehat{q}^*\right)\right) - D(p, \widehat{q}^*)k'\left(\widehat{q}^*\right)\right] \\ &= 0. \end{aligned} \tag{5}$$

When we substitute from the first-order condition for q_{BR} in (2), this can be written as

$$\begin{aligned} \frac{d\Pi(p, \widehat{q}^*, \widehat{q}^*)}{dp} &= \left[p - k\left(\widehat{q}^*\right)\right] D_p(p, \widehat{q}^*) + D(p, \widehat{q}^*) \\ &\quad + \frac{d\widehat{q}^*}{dp}\left(1 - \gamma\right)\left[p - k\left(\widehat{q}^*\right)\right] D_q(p, \widehat{q}^*) \\ &= 0. \end{aligned} \tag{6}$$

As noted above, the second line in (6) is equal to zero when all consumers are informed so that the first-order condition is obtained from the partial derivative with respect to the price.

Lemma 2 *In the equilibrium of the auxiliary model, the optimal price p that is chosen by the manufacturer in $t = 1$ solves (6).*

We again suppose that there is a unique price equilibrium. We denote this price by p^* with corresponding quality $\widehat{q}^*(p^*) = q^*$. We will make use of condition (6) in our extended model below. Further, we will provide an illustration of the equilibrium characterization in the following section, where we make use of the presently solved auxiliary model.

3 Intermediation and Negotiations

3.1 Introduction

We now introduce retailers indexed by $n = 1, ...N$. As will become clear from the following analysis, when there is only a single retailer, then the interests of the manufacturer and of the single retailer (with respect to how the retail price is set) will be perfectly aligned. This is, however, no longer the case when there are multiple retailers, even when they are not in competition with each other. In fact, below we will isolate two different sources of such a conflict of interest, one arising from a free-riding problem and one arising from the way retail prices affect outside options and, thereby, the distribution of surplus through negotiations. For this analysis, we have to first set up and provide a solution to the bargaining problem between the manufacturer and retailers. This is done in the present section.

Timing of Strategies. We begin with an introduction of the timing of strategies in our model. As noted previously, we take here the stance that the choice of the retail price level should be relatively persistent, giving rise to a particular "price image" with consumers. Outside clearly specified and limited promotional activities, retailers - and even more so manufacturers - may indeed want to provide such a consistent price image.[13] In our model, it is still in the first period $t = 1$ that retail prices are set, which we now denote as p_n. We comment shortly on what this implies for the timing and role of wholesale prices.

In $t = 2$ the manufacturer makes his choice of quality. Before demand is realized, as consumers make their choice, in the presence of retailers there are now negotiations in $t = 3$.

In the literature, the typical timing is different as it presumes that first wholesale contracts and supply relationships are determined before then retail prices are chosen. This set-up seems to accord well with the picture that manufacturers and retailers meet rarely, possibly even only once a year, to determine (once-and-for-all, at least for the duration that the game covers) the terms and conditions of supply while, on the other hand, retail prices are adjusted more flexibly and frequently so as to reflect, for instance, changes in local demand. Though long-term (yearly) contracts are often used in practice, the extent to which these contracts prescribe terms of delivery in detail varies considerably. Notably, to our knowledge, in the UK grocery industry such yearly agreements are much less detailed than in some other European countries (such as Germany or France) and, moreover, there is continuous pressure to renegotiate on additional payments throughout or, particularly, at the end of the year. As the retailer "owns" the shelf space and can

[13] There are also menu costs associated with a change of retail prices, as emphasized in the macroeconomic literature (cf. recently Nakamura and Steinsson 2008, who document also a higher frequency of relatively small rather than larger price changes). The picture of a rather consistent price - in particular, outside promotions - is also confirmed by Hosken and Reiffen (2004). For a model that derives a relative persistence of prices from consumers' preferences (given loss aversion) see Heidhues and Köszegi (2008).

always simply (temporarily) stop ordering a product without being in breach of contract, there is indeed no reason why he should not repeatedly approach suppliers to obtain additional concessions.

RPM and the Choice of "Price Ownership". There is one implication of our timing that deserves particular discussion. By putting wholesale contracting at the end, our timing deprives wholesale contracts of their possible steering role. In fact, below we will compare two different scenarios: that where, in $t = 1$, retailers set prices individually and that where this is done by the manufacturer. Clearly, the latter requires a binding contract and thus the legality of RPM. While in our model wholesale prices can not be used as a substitute, given the timing of strategies, we would argue that in practice this is frequently also not the case even for purely legal reasons.

In a model where the timing is reversed, when there are no additional complications related to uncertainty or limited observability, through the judicious use of marginal wholesale prices a manufacturer could incentivize a particular retail price, possibly also supported by communicating an indicative retail price and the threat of suspension of deliveries. While it seems that in the US these practices were deemed legal already for a long time (e.g., the threat of suspension of delivery under the so called "Colgate doctrine"; cf. the introduction), this is not the case in Europe.[14] There, competition authorities are suspicious even about the possible use of (nonlinear) wholesale contracts as inducements to substitute for outright RPM.

Noteworthy in this respect is the stance of the German competition authority. In its recent guidance to manufacturers, it noted that while handing over a list of recommended retail prices was deemed permissible, further discussions about the retail price that could be interpreted as coming to a mutual agreement were not permitted.[15] In this respect, also the use of “incentives” to achieve a particular retail price are considered to be suspiciously close to such an agreement. Such a wide enforcement of a ban on RPM and on other means through which manufacturers may exert control over prices further justifies the stark difference between retailer "price ownership" and manufacturer "price ownership", with respect to the choice of the retail price in $t = 1$, that we make in this paper.

[14] Cf. Waelbroeck (2006).

[15] Bundeskartellamt (2010).

3.2 Bargaining Solution Concept

Negotiations in $t = 3$ serve, as we noted above, the role of distributing the surplus. We model these negotiations through a network of bilateral negotiations, in each of which the manufacturer and the respective retailer can threaten to "hold up" supply or demand. While our model is only "one-shot", as noted above we view this more broadly as representing the continuous (re-)negotiations between manufacturers and retailers about additional concessions.

To model negotiations, we build on the "contingent contracting" approach in Inderst and Wey (2003), albeit - as we discuss below - the requirements that this approach imposes are shared with various other recent solution concepts. Our choice is motivated by two considerations. The first rationale, which also motivates other approaches in the same spirit (cf. below), is that thereby the solution will condition on the payoffs that parties achieve under various circumstances, notably when there is failure of agreement with different retailers. The second rationale is tractability. One of the contribution of this paper lies thus, in our view, also in the presentation of our solution concept.

Notation and Definitions. Denote the manufacturer by M and each retailer by Rn with $n = 1, ..., N$. As we discuss below, oour subsequently introduced solution concept leads to a well-known outcome in the axiomatic game theory literature: the "Myerson-Shapley value". Other than in much of the respective literature, which we review below, our particular application allows us to work with a very simple notation. The first reason for this is that one party, the manufacturer, plays a pivotal role for agreements. The other reason is the following. For $t = 1$ we focus on a symmetric price equilibrium. We therefore have to consider at most the case where, in case retailers control prices, a single price is different. Given that retail markets are otherwise symmetric, at $t = 3$ we can thus restrict consideration to cases where all but one retailer are symmetric with price p and where at most one retailer's price differs. Without loss of generality we assume that this is retailer $R1$, so that at most $p_1 \neq p$.

From the preceding observations, any set of agreements that may arise can thus be described by two pieces of information: whether $R1$ has come to an agreement or not and how many of the N retailers have altogether come to an agreement with the manufacturer. We denote the event that there was an agreement with $R1$ through a superscript 1 and the event where there was no such agreement through a superscript 0 in our following notation. The number of agreeing retailers is denoted by the respective number n. With this at hands, denote by $\Pi^1_{In}(n)$ the *joint* profits of the coalition that agrees with M, which here includes $R1$ (as denoted by the superscript 1) and altogether n retailers (i.e., also $n-1$ other retailers). For this contingency, $\pi^1_{Out}(n)$ denotes the *individual* profit of each of the non-agreeing $(N-n)$ retailers. Note that for our subsequently obtained results we need not be more specific about the strategies chosen by non-agreeing retailers. We will however do so when presenting explicit results for the case with linear demand below. Also note that the reduced form expressions suppress the dependency on retail prices, that is p_1 and p, as well as quality $\widehat{q}^*$. How quality and quality perceptions, which under rational expectations must still be the same, depend on all retail prices will be analyzed subsequently.

When there is agreement with n retailers but no agreement with $R1$, $\Pi^0_{In}(n)$ denotes again the *joint* profits of the coalition with M (now without $R1$), while we must now introduce a separate notation for the non-agreeing retailers, namely $\pi^0_{Out,R1}(n)$ for the non-agreeing retailer $R1$ and $\pi^0_{Out,Rn}(n)$ for each of the other $(N-n-1)$ non-agreeing retailers.

To rehearse the logic of the introduced notation, consider total industry profits for the various contingencies. Suppose again first that there is an agreement with $R1$. Then total industry profits are equal to the sum of $\Pi^1_{In}(n)$ and $(N-n)\pi^1_{Out}(n)$. If there is agreement with n retailers but not with $R1$, then total industry profits are the sum of the following three components: $\Pi^0_{In}(n)$ for the coalition, $\pi^0_{Out,R1}(n)$ for the non-agreeing retailer $R1$, and $(N-n-1)\pi^0_{Out,Rn}(n)$ together for all other non-agreeing retailers. Note also that when no retailer agrees with the manufacturer, then $\Pi^0_{In}(0)=0$.

Bargaining Solution Concept. In each bilateral negotiation, we suppose that the two parties achieve a "fair" (or "balanced") distribution of surplus for any possible contingency that can arise, where a contingency refers to the set of successful agreements. For instance, when there are only two retailers so that $N=2$, then an agreement between M and $R1$ specifies two transfers: one transfer that applies when there is also an agreement with $R2$, which will be the case on equilibrium, and another transfer when no such agreement with $R2$ materializes, which will be off equilibrium.[16] "Balancedness" requires that each transfer ensures that incremental benefits from the additional agreement (here: that between M

[16] Note again that we can restrict consideration to such simple transfers as we consider retail prices to be set more long-term and thus, in particular, already in $t=1$. That is, as discussed previously, also in view of the respective restrictions imposed by the enforcement of a ban on RPM through various competition authorities, we thereby abstract from the channel management role that (marginal) wholesale prices could have.

and $R1$) are shared equally between the two parties.[17]

We extend the previously introduced notation for profits to payoffs of the different parties and for different agreements. Note first that the payoff without an agreement is given by the respective profits ($\pi^1_{Out}(n)$, $\pi^0_{Out,R1}(n)$, or $\pi^0_{Out,Rn}(n)$). When $R1$ and M agree, the respective payoffs of M and $R1$ are denoted by $V^1_M(n)$ and $V^1_{R1}(n)$. Then, the payoff of each of the other $n-1$ agreeing retailers is denoted by $V^1_{Rn}(n)$. When $R1$ and M do not agree, the payoff is denoted by $V^0_M(n)$ for the manufacturer and by $V^0_{Rn}(n)$ for each of the n retailers that agree with him. Note that we do not need to introduce a separate notation for the respective bilateral transfers that give rise to these payoffs inside the agreeing coalition.

3.3 Bargaining Outcome

The following characterization will be restricted to prices set in $t=1$ that ensure that joint profits are maximized with the "grand coalition", $n=N$. This implies, in particular, that the possibly deviating price p_1 does not fall too short of p. This restriction is clearly without loss of generality, provided the alternative supply option is sufficiently unattractive.

Proposition 1 *When there are N retailers, suppose that at $N-1$ retailers the same price p prevails, while one retailer chooses potentially a different price. Assume wlog that the latter retailer is $R1$. The bargaining outcome must satisfy the imposed property of "balancedness" across all contingencies (i.e., all possible sets of agreements). Then, the payoff of the manufacturer equals*

$$V_M(N) = \frac{1}{N(N+1)} \left[\begin{array}{c} \sum_{i=0}^{N-1} (i+1) \left[\Pi^1_{In}(i+1) - \pi^0_{Out,R1}(i) - i\pi^1_{Out}(i) \right] \\ + \sum_{i=1}^{N-1} \sum_{j=1}^{i} \left[\Pi^0_{In}(j) - j\pi^0_{Out,Rn}(j-1) \right] \end{array} \right] \tag{7}$$

and that of the potentially deviating retailer $R1$

$$V_{R1}(N) = V_M(N) + \pi^0_{Out,R1}(N-1) - \frac{1}{N} \sum_{i=1}^{N-1} \left[\Pi^0_{In}(i) - i\pi^0_{Out,Rn}(i-1) \right]. \tag{8}$$

Proof. See Appendix.

We will later use these expressions to study retailer and manufacturer preferences for potentially different retail prices and the thereby induced quality levels. For this purpose

[17] This naturally presumes that contracting precedes under symmetric information with respect to all retail prices p_n as well as the actually chosen quality q.

actually only the respective difference in profits will prove relevant:

$$V_M(N) - V_{R1}(N) = \frac{1}{N} \sum_{i=1}^{N-1} \left[\Pi^0_{In}(i) - i\pi^0_{Out,Rn}(i-1) \right] - \pi^0_{Out,R1}(N-1). \tag{9}$$

The proof of Proposition 1 derives the respective expressions by a simple inductive argument. This is relatively straightforward given the various restrictions that follow from our application, in particular that all contracts are with M and that all retailers except possibly one are symmetric.

As we are looking for a symmetric equilibrium in prices, from $p_1 = p$ all retailers inside a coalition and thouse outside will be the same. This allows to considerably simplify the respective expressions (7) and (8). In this case, that is when $p_1 = p_n = p$, we thus have the following. First, the profit for a retailer without an agreement only depends on the number of agreeing retailers and no longer on the respective identity: $\pi_{Out}(n)$. (That is, $\pi^0_{Out,R1}(n) = \pi^0_{Out,Rn}(n) = \pi^1_{Out}(n) =: \pi_{Out}(n)$.) Second, we can also express the joint profits of an agreeing coalition as the sum of bilateral profits (gross of transfers): $\Pi^1_{In}(n) = n\pi_{In}(n)$. With this at hands, for symmetric prices we thus obtain after some transformations

$$V_M(N) = \frac{1}{N+1} \sum_{n=1}^{N} n \left[\pi_{In}(n) - \pi_{Out}(n-1) \right]. \tag{10}$$

For what follows, we only need additionally the difference in profits between the manufacturer and now any of the symmetric retailer. Using (9) this transforms to

$$\frac{1}{N} \left[\sum_{n=1}^{N-1} n\pi_{In}(n) - \sum_{n=1}^{N} n\pi_{Out}(n-1) \right]. \tag{11}$$

As noted above, we could also have obtained the characterization in Proposition 1 by appealing to other recently obtained solution concepts and results in the bargaining literature. In particular, Navarro (2007) derives a bargaining value for general networks (with externalities) by extending the "fair allocation rule" of Myerson (1977). This requirement is equivalent to the requirement of an equal sharing rule for all contingencies, as used for Proposition 1. Further, this value is also obtained in De Fontenay and Gans (2013) from a non-cooperative approach, where an individual disagreement restarts negotiations.[18] This specification ensures that, as in our solution concept, equilibrium payoffs depend on the potential profits under all other coalitions.

[18] Other recent derivations of bargaining values for externalities (albeit restricted to coalitional structures) are, for instance, Macho-Stadler et al. (2007) or De Clippel and Serrano (2008).

4 Reputation Spillover

In this section, we abstract from downstream retail competition. Subsequently, we will introduce competition to isolate additional effects that can give rise to conflicts of interest between retailers and manufacturers as to the quality level that particular price choices induce in our model.

Without competition, the profits that are realized at any given retailer do not depend directly on whether the manufacturer's product is also sold at other retailers (and at what price). This allows to isolate the aforementioned free-riding problem, on which this section focuses. However, we still suppose that consumers are aware of the prices that have been set at all other retailers. For instance, this could be through advertising, but also through other shopping trips that are, however, not considered to be substitutes (e.g., as the product is not storable and consumers only decide on the basis of convenience at any given instance).

4.1 Equilibrium Quality and Prices

Without downstream competition, profits realized at an individual retailer do not depend on choices at other retailers. We thus first further simplify notation by writing π_{Out} for the "outside option" payoff of each retailer (irrespective of the identity of the agreeing coalition). Also with an agreement bilateral profits do not depend directly on the choices made at other retailers. Denote by $\pi(p_n, q, \widehat{q})$ the respective profits, which thus depend only on the respective price p_n as well as actual and perceived quality. We will first make use of this notation to derive equilibrium quality at stage $t = 2$, $\widehat{q}^* = \widehat{q} = q$. Subsequently, we can further simplify notation by substituting for this.

Choice of Quality. At $t = 2$ the manufacturer chooses q to maximize his own payoff. With the preceding observations and making use of Proposition 1, without competition we have

$$V_M(N) = \frac{1}{2}\left[\sum_{n=1}^{N} \pi(p_n, q, \widehat{q}) - N\pi_{Out}\right], \tag{12}$$

so that

$$q_{BR} = \arg\max_q \sum_{n=1}^{N} \pi(p_n, q, \widehat{q}).$$

Or, with the first-order condition as in (2), q_{BR} solves

$$\gamma\left[\sum_{n=1}^{N}\left(p_n-k(q_{BR})\right)D_q\left(p_n,q_{BR}\right)\right]-k'(q_{BR})\sum_{n=1}^{N}\left[\gamma D(p_n,q_{BR})+(1-\gamma)D(p_n,\widehat{q})\right]=0. \tag{13}$$

Recall that at this stage we solve for the equilibrium where a consumer who does not observe quality holds rational beliefs, so that $q_{BR}=\widehat{q}=\widehat{q}^{*}$. Note again that profits in one retail market currently depend on the price in another retail market only through the effect that the other price has on the manufacturer's incentives to adjust quality - and, for $\gamma<1$, on the respective beliefs of uninformed consumers. Hence, the equilibrium requirement for $\widehat{q}^{*}$ at $t=2$ is that, in analogy to condition (3),

$$\gamma\left[\sum_{n=1}^{N}\left(p_n-k(\widehat{q}^{*})\right)D_q\left(p_n,\widehat{q}^{*}\right)\right]-k'(\widehat{q}^{*})\sum_{n=1}^{N}D(p_n,\widehat{q}^{*})=0. \tag{14}$$

As in (3) we obtain again $d\widehat{q}^{*}/dp_n$ but refer the respective expression to the proof of Proposition 2.

Equilibrium Prices. For given prices and at the thereby induced quality, we can now abbreviate bilateral profits at each retailer as $\pi(p_n,\widehat{q}^{*})$. We are interested in how the optimal choices of prices in $t=1$ differ when these are controlled by retailers or the manufacturer.

Suppose first that the manufacturer could also control retail prices, which presumes the legality of RPM. Though this does not affect results given symmetry of retail markets, suppose the manufacturer would choose a symmetric price $p_n=p$. From the expression in (12) for $V_M(N)$, now simplified by using the induced quality $\widehat{q}^{*}$ and thus bilateral profits $\pi(p_n,\widehat{q}^{*})$, it is immediate that the manufacturer chooses the same price as in the case of vertical integration:

$$p_M^{*}=\arg\max_{p=p_n}\pi(p,\widehat{q}^{*}).$$

This is in particular not affected by the number of retailers. As we explore in the following section, this is clearly only the case as retailers presently operate in segmented markets. As p_M^{*} is independent of N, this holds also for the resulting quality $\widehat{q}_M^{*}$.

We compare this outcome now with the case where in $t=1$ each individual retail price is chosen optimally by the respective retailer. As discussed above, we refer to this as the case where retailers have "price ownership" and we focus on a symmetric equilibrium: $p_n=p_R^{*}$. With segmented retail markets, recall that the choice of p_n has no direct impact on demand in other markets. However, such an externality exists through the implications that this has on quality perceptions and thus ultimately on $\widehat{q}_M^*$, given $d\widehat{q}^*/dp_n > 0$. The retailer takes into account only the implication that a higher quality has on demand in his own market:

$$p_R^* = \arg\max_{p_n} \pi(p_n, \widehat{q}^*).$$

An individual retailer thus fails to take into account the positive demand externality that works through the induced quality perception. Note that a wedge between p_M^* and p_R^* only exists when quality perceptions matter, as quality is not perfectly observed by all consumers. In fact, when quality is always observed, then at $t = 2$ it is chosen to maximize total industry profits, in which case (by the envelope theorem) the marginal impact of a higher quality, as induced by an increase in any given retail price p_n, is zero.[19] This is, however, different when from $\gamma < 1$ quality is, for given prices, always inefficiently low also from the perspective of maximizing industry profits. Then, through the prevailing higher retail price, also quality is strictly higher when the manufacturer determines the retail price: $q_M^* > q_R^*$.

Proposition 2 *Consider the case with non-competing retail markets. Suppose that uninformed consumers take into account all price observations when forming beliefs about the prevailing quality. Then, the manufacturer's preferred retail price, p_M^*, is the same as that chosen by retailers, p_R^*, only when $\gamma = 1$, while otherwise it is strictly higher ($p_M^* > p_R^*$). In the latter case, quality is strictly higher when the manufacturer determines the retail price ($q_M^* > q_R^*$).*

Proof. See Appendix.

The difference when retailers determine the price is thus brought about by a free-riding problem. In contrast to previous contributions, as surveyed in the introduction, the mechanism in our paper applies in particular to branded products, where quality and its perception matter, and it does not rely on the provision of other (non-contractible) services performed by retailers. In fact, the non-contractible action is that of providing (higher) quality and it is performed by the manufacturer. The free-riding problem increases with the number of markets.

[19] Strictly speaking, this holds under symmetric prices $p_n = p$, i.e., when considering deviations from the equilibrium.

Corollary 1 *For $\gamma \in (0,1)$ the difference between the optimal retail prices with manufacturer and retailer "price ownership", $p_M^* - p_R^* > 0$, is strictly increasing in N. Consequently, also the difference in provided quality is strictly increasing in N.*

Proof. See Appendix.

It is worthwhile to note that while p_M^* clearly maximizes the manufacturer's profits, the price that prevails under retailer "price ownership", p_R^*, does not maximize the profits of retailers. In fact, retailers would jointly be strictly better off when setting $p_n = p_M^*$, i.e., the price that would prevail under manufacturer "price ownership". However, as is the essence of a free-riding problem, they have a private incentive to deviate by setting a strictly lower price. Interestingly, the coincidence of p_M^* and the symmetric price that would maximize total retailer profits does no longer hold when we introduce retailer competition in the following section.

In what follows we turn to a particular specification of demand and costs to study the welfare implications of "price ownership" by either retailers or the manufacturer in our model.

4.2 Welfare Comparison

We consider again the case of linear demand $D(p_n, q) = q - p_n$ and constant marginal cost of production $\frac{1}{2k}q^2$. Joint profits of the manufacturer together with retailer n are then given by

$$\pi(p_n, q, \widehat{q}) = (q_\gamma - p_n)\left(p_n - \frac{1}{2k}q^2\right),$$

where we use $q_\gamma = \gamma q + (1-\gamma)\widehat{q}$. The linear demand structure allows us to write the equilibrium condition for $\widehat{q}^*$ in (14) in terms of the average retail price $\overline{p} = \frac{1}{N}\sum_{n=1}^{N} p_n$:

$$\gamma\left(\overline{p} - \frac{1}{2k}\left(\widehat{q}^*\right)^2\right) - \frac{1}{k}\widehat{q}^*\left(\widehat{q}^* - \overline{p}\right) = 0. \tag{15}$$

Implicit differentiation shows how the thereby induced quality level depends on the average retail price $\overline{p}$:

$$\frac{d\widehat{q}^*}{d\overline{p}} = \frac{k\gamma + \widehat{q}^*}{(2+\gamma)\widehat{q}^* - \overline{p}}.$$

The respective expression for an individual retail price p_n is given simply by

$$\frac{d\widehat{q}^*}{dp_n} = \frac{1}{N}\frac{d\widehat{q}^*}{d\overline{p}}.$$

Moreover, we can also solve explicitly for $\widehat{q}^*$ as a function of the average retail price:

$$\widehat{q}^* = \frac{\overline{p} + \sqrt{\overline{p}^2 + \overline{p}2\gamma (2+\gamma) k}}{2+\gamma}. \tag{16}$$

The first-order condition for retailer price ownership, $p_n = p = p_R^*$, becomes

$$\left(\frac{1}{N}\right) \frac{(\gamma k + \widehat{q}^*) \left(p - \frac{\widehat{q}^*(3\gamma - 2p)}{2k}\right)}{(\gamma+1)\widehat{q}^*} + \frac{(\widehat{q}^*)^2}{2k} - 2p + \widehat{q}^* = 0. \tag{17}$$

Note that the respective condition for manufacturer price ownership, $p_n = p = p_M^*$, is also given by (17) when setting $N = 1$. This follows simply as, first, with $N = 1$ there is no difference between the two cases and as, second, p_M^* does not depend on N, as noted above.

To compare efficiency, from the utility function of the respective representative consumer we obtain in each market the consumer surplus

$$CS = \frac{1}{2}(q-p)^2$$

and finally total welfare in each market of

$$W = \frac{1}{2}(\widehat{q}^* - p)^2 + (\widehat{q}^* - p)(p - k(\widehat{q}^*)).$$

Both CS and W will now be compared at the respective choices of prices p_M^* and p_R^* and the thereby induced qualities.

Before turning to efficiency however it is instructive to compare the respective prices. As is immediate, and proven generally in Corollary 1, p_R^* is strictly decreasing in the number of retail markets, while p_M^* remains constant. Recall that the strict monotonicity of p_R^* follows from the fact that the free-riding problem (with respect to consumers' perception of quality) becomes more severe as there is a larger number of separate markets. We focus our comparison in what follows on the case where the difference between the two scenarios is largest, namely by letting $N \to \infty$. (For brevity we write more simply $N = \infty$.) Then, the choice of p_R^* does not internalize at all the implications that prices have on quality perception. In fact, expression (17) simplifies to

$$\frac{(\widehat{q}^*)^2}{2k} - 2p_R^* + \widehat{q}^* = 0,$$

where we have substituted for $p = p_R^*$. All our results in this section will be obtained for this case.

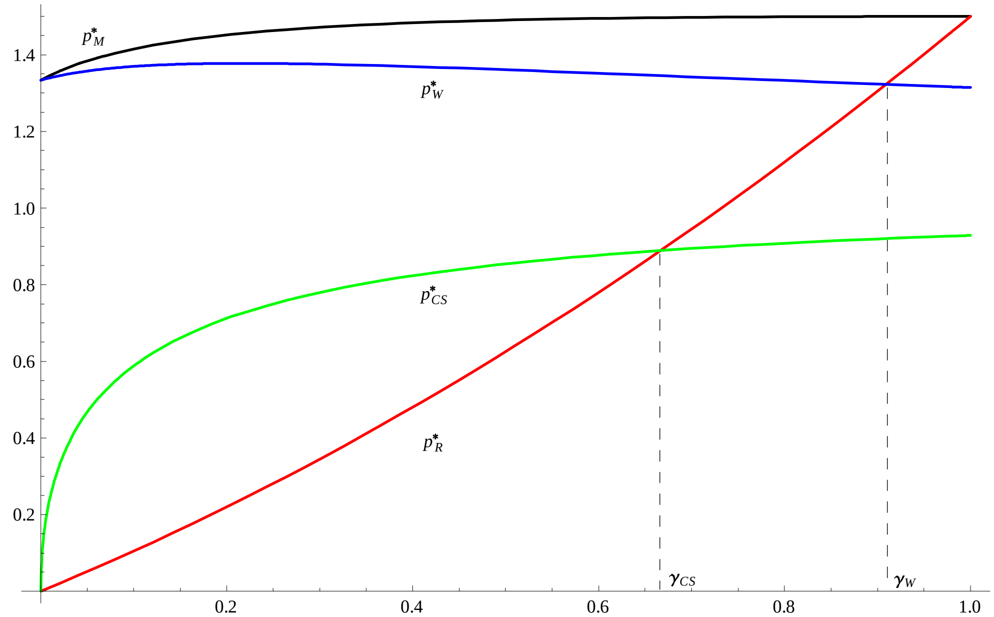

Figure 1: This figure shows p_M^* and p_R^*, next to the prices that maximize welfare, p_W^*, and consumer surplus, p_{CS}^*, as a function of γ. Parameter values are $k = 2$ and $N = \infty$.

For a particular numerical specification, Figure 1 plots the two prices p_M^* and p_R^* as a function of the degree of transparency about quality, γ. Prices are the same when $\gamma = 1$, as then quality perceptions do not matter. For all lower values of γ we have $p_M^* > p_R^*$.[20] In Figure 1 we have also characterized the prices that would maximize total welfare and consumer surplus, p_W^* and p_{CS}^*. Intuitively, it holds that $p_W^* > p_{CS}^*$, as total welfare is not affected by mere transfers from consumers to firms. Further, at $\gamma = 1$ note that both efficiency benchmark prices are strictly lower than the price that would be obtained in the market, $p_M^* = p_R^*$.

We now compare the retailers' individually preferred price p_R^* with the two efficiency benchmarks. When quality perception is not important as γ is large, also p_R^* is strictly above both benchmarks. However, as γ becomes sufficiently low, p_R^* falls below both the price p_W^* that would maximize total welfare (when $\gamma < \gamma_W$) and the lower price p_{CS}^* that would maximize consumer surplus (when $\gamma < \gamma_{CS}$). Proposition 3 shows that these results hold generally for our specification.

From the preceding observations we already know that for $\gamma = \gamma_{CS}$ consumer surplus would be strictly higher under retailer "price ownership". At this level of transparency it

[20] That both prices are increasing in γ is due to the fact that, for given p, the resulting equilibrium quality is then larger, which has a demand expanding effect. This property may however not hold generally (i.e. for other functional specifications of demand and cost).

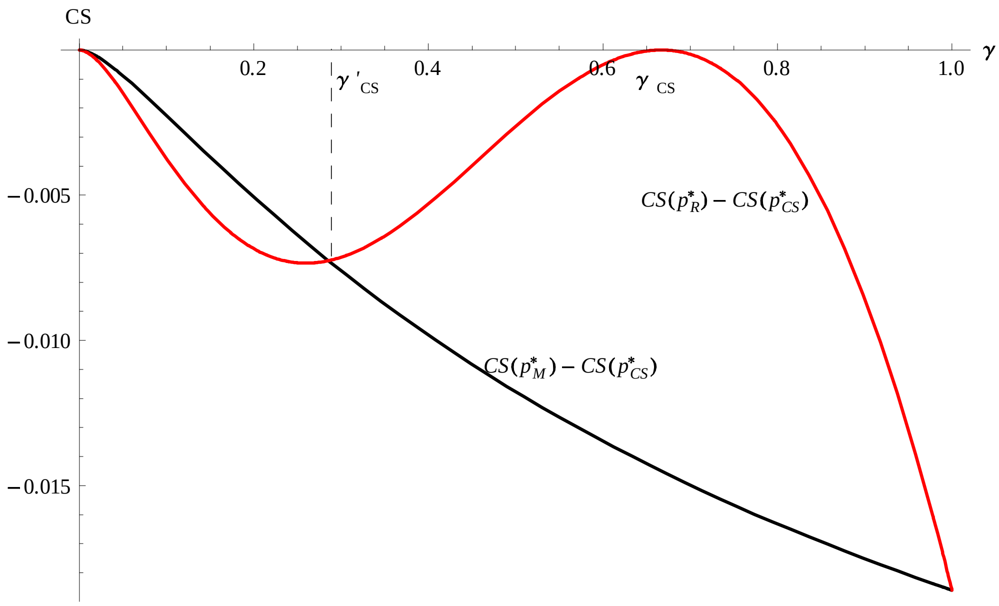

Figure 2: Consumer surplus for p_M^* and p_R^*, net of maximum consumer surplus at p_{CS}^*, as a function of γ. Parameter values are $k = 2$ and $N = \infty$.

holds that $p_R^* = p_{CS}^*$, while the price obtained under manufacturer "price ownership" is too high, $p_M^* > p_{CS}^*$. More generally, Figure 2 plots across all γ the difference between consumer surplus under the various prices. With respect to the comparison of p_{CS}^* and p_R^*, where the respective difference is $CS(p_R^*) - CS(p_{CS}^*)$, note that other than at $\gamma = 0$, where demand becomes zero, and at $\gamma = \gamma_{CS}$ the difference is obviously strictly negative. When we compare instead $CS(p_{CS}^*)$ with the respective consumer surplus under the manufacturer's preferred price, $CS(p_M^*)$, then other than at $\gamma = 0$, where demand becomes zero, the difference is always negative. Still, we see from Figure 2 that for low γ consumer surplus is strictly higher under manufacturer "price ownership" than under retailer "price ownership". In fact, there is a threshold value γ'_{CS} so that $CS(p_M^*) > CS(p_R^*)$ holds for low levels of transparency $0 < \gamma < \gamma'_{CS}$ and $CS(p_M^*) < CS(p_R^*)$ holds for high levels of transparency $\gamma'_{CS} < \gamma < 1$.

Proposition 3 generalizes this result by showing that for the chosen linear-quadratic specification consumer surplus is indeed strictly higher with p_M^* for low γ and strictly higher with p_R^* for high γ. An analogous result holds with respect to total welfare, which is also strictly higher under manufacturer "price ownership" than under retailer "price ownership" when transparency is low, while the opposite holds when transparency is high. Figure 3 illustrates this again for the chosen numerical specification. This yields again a threshold value γ'_W so that $W(p_M^*) > W(p_R^*)$ holds for low levels of transparency $0 < \gamma < \gamma'_W$

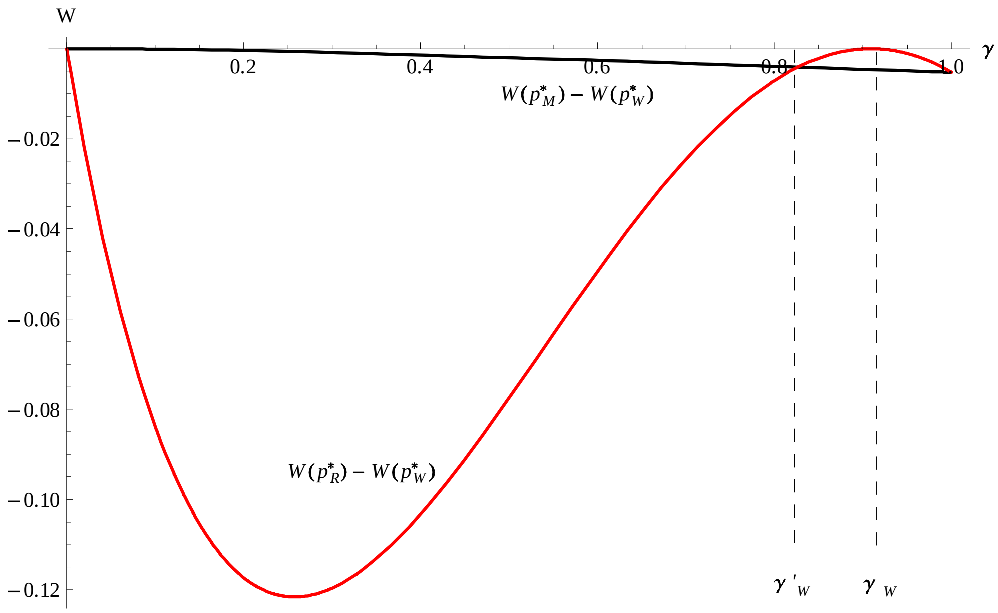

Figure 3: Total welfare for p^*_M and p^*_R, net of maximum consumer surplus at p^*_W, as a function of γ. Parameter values are $k = 2$ and $N = \infty$.

and $W(p^*_M) < W(p^*_R)$ holds for high levels of transparency $\gamma'_W < \gamma < 1$. The respective threshold is strictly higher than that obtained for the comparison of consumer surplus, $\gamma'_W > \gamma'_{CS}$.

Together, the comparison of consumer surplus and welfare brings out two key insights. The first is that from the perspective of both consumer surplus and welfare, efficiency can be higher either with p^*_M or with p^*_R. This holds despite the fact that in our model the price is always lower under retailer "price ownership", $p^*_R < p^*_M$ (other than for $\gamma = 1$). The reason is that endogenous quality is strictly higher when a higher price is set. The second insight is the role of quality transparency and thereby of consumers' quality perception. In the linear-quadratic specification, the free-riding problem under retailer "price ownership" becomes sufficiently important when the fraction of consumers who do not observe quality is sufficiently large, so that in this case consumer surplus and total welfare are both strictly lower under the respective price p^*_R than under the price that is optimally chosen by the manufacturer, p^*_M.

Proposition 3 *In the linear-quadratic specification with $N = \infty$, so that the free-riding problem is maximal, the following comparison of prices and efficiency (in any given market) holds:*

i) For low levels of transparency γ, the price preferred by retailers is strictly below both

the price that would maximize consumer surplus and the price that would maximize total welfare ($p_R^* < p_{CS}^*$ and $p_R^* < p_W^*$), while for high values it is strictly higher than both ($p_R^* > p_{CS}^*$ and $p_R^* > p_W^*$). The price preferred by manufactures is always strictly higher than both efficiency benchmarks ($p_M^* > p_{CS}^*$ and $p_M^* > p_W^*$).
ii) For low levels of transparency γ, both consumer surplus and welfare are strictly higher under the manufacturer's preferred price ($CS(p_M^*) > CS(p_R^*)$ and $W(p_M^*) > W(p_R^*)$), while for high values the opposite holds ($CS(p_M^*) < CS(p_R^*)$ and $W(p_M^*) < W(p_R^*)$).

Proof. See Appendix.

5 Retailer Competition

5.1 Introductory Remarks

We now introduce competition. For now we will also continue to work with the reduced form model and the respective expressions for profits derived in Proposition 1. Note that through competition, prices will also affect the profits of those retailers that (off-equilibrium) no longer stock the manufacturer's product. However, for our purposes we presently need not be more specific about the strategies of a non-agreeing retailer.

Auxiliary Case: Exogenous Quality. To set the stage, consider the following auxiliary case. We suppose only for now that quality is exogenously given and can thus in particular not be influenced by prices. The analysis helps us to clarify subsequently the difference that quality choice as well as consumers' perceptions of quality imply for optimal prices under retailer and manufacturer "price ownership".

Our first observation is that when quality is exogenously given, retailers and the manufacturer have exactly the same preference regarding prices, regardless of competition. This can be seen immediately from inspecting the respective difference in profits in expression (9). All terms in this expression relate to the contingency where there is no agreement with retailer $R1$. (Recall that for the derivation of the bargaining solution we specified without loss of generality that only one retailer, $R1$, may have set a deviating price $p_1 \neq p$ at $t = 1$.) Consequently, there is also no direct role for the respective price p_1. Formally, we thus have that

$$\frac{\partial}{\partial p_1} \left[V_M(N) - V_{R1}(N) \right] \Big|_{q \text{ fixed}} = 0. \tag{18}$$

This immediate observation is important as it ensures that the subsequently discussed conflict of interest between retailers and the manufacturer is due only to the implications that the price has for quality and quality perceptions. This holds irrespective of whether retail markets are segmented, so that there is no competition as in the analysis in the preceding section, or there is competition between retailers. Put differently, our chosen set-up obtains the result that when quality is exogenous, then there is no conflict of interest between retailers and the manufacturer in the determination of the retail price. However, when quality choice is endogenous, then such a conflict of interest exists, as we analyze next.

5.2 Analysis

Our focus is again on the difference that "price ownership" generates, both with respect to the optimal price and with respect to the resulting quality. As for the analysis without competition, we thus need to sign the derivative of the profit difference (9) with respect to the retail price of the potentially deviating retailer $R1$: $V_M(N) - V_{R1}(N)$. By the preceding remarks however this can be much simplified as we only need to consider the implications that a price change has on quality, but not the direct effect of the price. That is, using as well that we analyze the outcomes at symmetric prices, in what follows we will need to sign the expression

$$\frac{d}{d\widehat{q}^*}\left[V_M(N) - V_R(\Omega)\right] = \frac{1}{N}\sum_{n=1}^{N-1} n \frac{d}{d\widehat{q}^*}\pi_{In}(n) - \frac{1}{N}\sum_{n=1}^{N} n \frac{d}{d\widehat{q}^*}\pi_{Out}(n-1). \tag{19}$$

The second sum in (19) captures the effects that a higher induced quality level has on the profits of non-agreeing retailers under various contingencies (i.e., depending on the number of agreeing retailers).[21] These terms generate a wedge between the preference of the manufacturer and that of any retailer. When with competition it holds that

$$\frac{d}{d\widehat{q}^*}\pi_{Out}(n) < 0 \text{ for } 1 \leq n \leq N-1,$$

then a higher quality of the manufacturer's product undermines the "outside option" of a non-agreeing retailer. This makes the manufacturer prefer a higher retail price as the thereby induced higher quality reduces retailers' profits when they do not come to an agreement with the manufacturer. This ultimately benefits the manufacturer. Clearly, without

[21] Note for completeness that clearly $\frac{d}{d\widehat{q}^*}\pi_{Out}(0) = 0$ as then there is no retailer that offers the incumbent manufacturer's product.

competition this effect is not present. The presently discussed effect isolates another mechanism through which a conflict of interest between retailers and the manufacturer can lead to a different preference for quality, as induced by a different choice of prices.

Without competition, we know already that the first term in (19) is zero when $\gamma = 1$ and otherwise strictly positive ("free riding" problem). More generally, it captures the effect that quality has on the joint profits of all agreeing retailers, again summed up over all possible contingencies, that is, whether one or up to $N-1$ retailers agree.[22] At first it may seem intuitive that all expressions $\frac{d}{d\widehat{q}^*}\pi_{In}(n)$ should be positive, i.e., that a higher quality increases "insiders'" profits, in particular when there is competition. However, this ignores the fact that the provision of quality is costly. To sign also this term and the whole expression, we proceed in two steps.

Transparency. Recall that for $\gamma < 1$ there is an opportunism problem vis-à-vis consumers who do not directly observe quality. Precisely, while for given prices the choice of q_{BR} maximizes the manufacturer's profits, $V_M(N)$, this is not so for the resulting equilibrium quality $\widehat{q}^*$. While in equilibrium it holds that $\widehat{q}^* = q_{BR}$, $\widehat{q}^*$ only satisfies the respective first-order condition when $\gamma = 1$. Consider now the problem to choose quality $\widehat{q}^*$ so as to maximize the profits of an agreeing coalition with n retailers, $n\pi_{In}(n)$. As γ becomes sufficiently small, it is intuitive that equilibrium quality is always too low, given the opportunism problem, regardless of the choice of $n = 1, ..., N$. Appealing to concavity, also the first term in (19) is then strictly positive.

Proposition 4 *Consider the general case where retailers can be in competition. In a given market, when* $\gamma > 0$ *is sufficiently small so that a large fraction of consumers must rely on quality perceptions, the optimal price and thereby induced quality are strictly higher under the manufacturer's preferred retail price.*

Hence, when transparency is low so that quality *perceptions* matter a lot, we can sign both terms in expression (19). The manufacturer's optimal choice of the retail price will then be strictly higher than that of retailers, implying also a strictly higher quality, both as the manufacturer cares about the positive impact of quality on his bargaining position (the second term) and as the manufacturer cares more about the problem of underprovision of quality due to the opportunism problem vis-á-vis consumers.

[22] The respective term for N agreeing retailers dropped out as here we consider the difference in profits between the manufacturer and a retailer.

Linear Demand. We now return to our specification with linear demand, for which we extend the quadratic utility function to the case with N differentiated retailers, implying that demand at retailer n is given by[23]

$$(q_n - p_n) - \delta \sum_{m \neq n} (q_m - p_m) . \tag{20}$$

We are now specific about the choices of non-agreeing retailers. Also applying the same timing of moves, we suppose that then consumers can buy a good of fixed quality q_0 and price p_0 at these retailers. This specification provides us with the most simple way to close the model. Considering again symmetric prices for the manufacturer's products, joint profits generated with one of n agreeing retailers are then given by

$$\pi_{In}(n) = [(1 - \delta (n-1)) (\widehat{q}^* - p) - \delta (N-n) (q_0 - p_0)] (p - k (\widehat{q}^*)) .$$

Profits of each one of the $(N-n)$ non-agreeing retailers are given by

$$\pi_{Out}(n) = [(1 - \delta (N-n-1)) (q_0 - p_0) - \delta n (\widehat{q}^* - p)] (p_0 - k_0) .$$

Proposition 5 *With linear demand, when there is competition it holds for all $\gamma > 0$ that equilibrium quality is strictly higher under the manufacturer's (higher) preferred price.*

Proof. See Appendix.

With linear demand we can also extend the discussion to welfare and relate this to a change in competition, δ. For this we abstract from the free-riding problem ($\gamma = 1$) such that quality is chosen to maximize $V_M(N)$, which also implies, by the envelope theorem, that the manufacturer's preferred price is determined by setting the partial derivative with respect to price equal to zero. With the linear demand specification, note that a marginal price reduction has the same demand expanding effect as a marginal increase in quality. Therefore, by optimality, also the marginal costs of an increase in quality ($k'(q)$) have to be equal to the "marginal cost" of a price reduction, which is equal to one. This can be used, together with the respective first-order conditions, to show that while the resulting preferred retail price p_M^* is strictly decreasing in δ, the thereby induced quality, q_M^* , remains constant.[24]

[23] That is, a representative consumer derives utility of $u(\boldsymbol{x}, q) = \sum_{n=1}^{N} \left[q_n x_n - \frac{1}{2}\beta x_n^2\right] - \phi \sum_{m \neq n} x_n x_m$, where x_n denotes the quantity bought at retailer n. Setting $\partial u / \partial x_n = p_n$ and solving for x_n yields (20), where $\delta = \phi / [(\beta - \phi)(\beta + (N-1)\phi)]$ and β and ϕ are such that $\frac{\beta + (N-2)\phi}{(\beta - \phi)(\beta + (N-1)\phi)} = 1$. Cf. Vives (1985).

[24] Precisely, from substituting the first-order conditions of $V_M(N)$ with respect to p and q, we obtain $k'(\widehat{q}_M^*) = 1$ and $\frac{dp_M^*}{d\delta} = \frac{-3}{2(3-2\delta)^2} [(q_0 - p_0) + 2(p_0 - k_0)]$.

An interesting observation is now that this choice of q_M^* may be excessively high from a welfare perspective, precisely because the manufacturer thereby affects his strategic position in subsequent negotiations. To see this, note that total welfare is now

$$W = N(1-\delta)\left[\frac{1}{2}(q-p)^2 + (q-p)(p-k(q))\right].$$

Stipulating as before $k(q) = \frac{1}{2k}q^2$, for given symmetric price p, the welfare maximizing quality can be explicitly stated as

$$q_W = \frac{2}{3}(k+p).$$

We evaluate this at $p = p_M^*$. Note that the welfare-maximizing quality q_W is strictly lower the lower is the respective price, given that then total demand is lower. But, as we observed previously, q_M^* stays constant. When competition is high (high δ), there may even be an excessive provision of quality in the sense that q_M^* is larger than the quality level that would – given the equilibrium price p_M^* – maximize total welfare. Solving for the critical δ, we get that quality is excessive if $\delta > \delta''$, where

$$\delta'' = \left(\frac{3}{2(N-1)}\right)\frac{k}{k+q_0-p_0+2(p_0-k_0)}.$$

For instance, when we specify again $k=2$ for costs and $p_0 = 0.5$, $q_0 = 1.5$, $k_0 = 0.1$ for the outside option, we have that quality is excessive in this sense when $\delta > \left(\frac{1}{N-1}\right)\frac{15}{19}$. Still, welfare may be higher though when the manufacturer controls the retail price. In fact, by explicitly calculating welfare under the two scenarios for $N = 2$, we find that although quality is excessively high (if $\delta > \delta'' \approx 0.79$), welfare is higher under manufacturer "price ownership" than under retailer "price ownership" if $\delta > 0.24$, i.e., when competition is sufficiently high.[25]

6 Concluding Remarks

We consider a manufacturer's incentives to choose quality in an environment where this is not observed directly by all consumers. We further ask how these incentives are influenced by the product's price when this is set more persistently (and thus, in the model, before quality is determined, e.g., through the choice of procured inputs or through the hygienic standard in production and distribution of the product). We derive various channels that

[25] Such a cutoff result can however not obtained more generally. In fact, we have found examples where, as we vary only δ, either regime can become more efficient for different intervals.

support the view that, under these circumstances, higher prices are associated with higher quality (and thus also rational beliefs of higher quality). This set-up is then embedded into a game where either retailers or the manufacturer initially choose the retail price ("price ownership").

In such a game, we derive different sources of a conflict in price setting between retailers and the manufacturer. Importantly, as we also show, such a conflict would, in our model, be fully absent when the product's quality was exogenous. Further, when quality was observed by all consumers, so that there was no true "reputation" for quality (with those consumers who do not directly observe the actual choice of quality), then this would also better align price-setting preferences.

One channel that supports such a conflict of interest works through a reputation spill-over across all retailers. Each individual retailer does not take into account how his price affects the overall perception of the product's quality and, thereby, also equilibrium quality choice. A second channel operates when there is competition between retailers. Then, a higher (perceived) quality, which would be triggered by a higher retail price, reduces a retailer's but increases the manufacturer's outside option in bilateral negotiations.

As we discussed in detail above, we adopt assumption that the retail price choice is relatively more persistent and, in the model, precedes (ongoing) negotiations over wholesale prices. We provided various rationales for this specification. We also indicated that this may represent a short-cut expression for a more dynamic model where prices set in previous periods affect future quality and quality perceptions (when quality is somewhat persistent). The dynamic interplay between wholesale and retail prices together with the ongoing choice of quality may provide an interesting research avenue for future work.

7 Appendix A: Omitted Derivations and Proofs

Proof of Proposition 1.

here we still need to change notation

Take first contingencies where there is no agreement with R_1, for which we have to determine $V_M^0(n)$ and $V_R^0(n)$. This is done recursively from the fair-sharing rule

$$V_M^0(n) - V_M^0(n-1) = V_{Rn}^0(n) - \Pi_{Out,Rn}^0(n-1)$$

and from the joint-profit condition

$$V_M^0(n) + nV_{Rn}^0(n) = \Pi_{In}^0(n),$$

which together yield

$$(n+1)V_M^0(n) = nV_M^0(n-1) + \left[\Pi_{In}^0(n) - n\Pi_{Out,Rn}^0(n-1)\right].$$

From this we obtain for the manufacturer

$$V_M^0(n) = \frac{1}{n+1}\sum_{i=1}^{n}\left[\Pi_{In}^0(i) - i\Pi_{Out,Rn}^0(i-1)\right]. \tag{21}$$

When there is agreement with R_1, we have for the sharing rule with another retailer

$$V_M^1(n) - V_M^1(n-1) = V_{Rn}^1(n) - \Pi_{Out,Rn}^1(n-1) \tag{22}$$

and for the sharing rule with $R1$

$$V_M^1(n) - V_M^0(n) = V_{R1}^1(n) - \Pi_{Out,R1}^0(n), \tag{23}$$

while the joint-profit condition is now

$$V_M^1(n) + nV_{Rn}^1(n) + V_{R1}^1(n) = \Pi_{In}^1(n).$$

Substituting yields

$$V_M^1(n) = \frac{1}{n+2}\left[nV_M^1(n-1) + V_M^0(n) + \Pi_{In}^1(n) - n\Pi_{Out,Rn}^1(n-1) - \Pi_{Out,R1}^0(n)\right]$$

Making use of (21) we obtain $V_M^1(n)$ and, together with (23) also $V_{R1}^1(n)$. Choosing $n = N-1$, together with agreement for $R1$, obtains the final characterization.[26] **Q.E.D.**

Proof of Proposition 2. For some retailer Rn we obtain the requirement

$$\begin{aligned}\frac{dV_{Rn}(\Omega)}{dp_n} &= D_p(p_n,\widehat{q}^*)(p_n - k(\widehat{q}^*)) + D(p_n,\widehat{q}^*) \\ &\quad + \left[D_q(p_n,\widehat{q}^*)(p_n - k(\widehat{q}^*)) - D(p_n,\widehat{q}^*)k'(\widehat{q}^*)\right]\frac{d\widehat{q}^*}{dp_n} \\ &= 0.\end{aligned} \tag{24}$$

For the manufacturer we obtain, in case he could choose p_n separately, the first-order condition

$$\begin{aligned}\frac{dV_M(\Omega)}{dp_n} &= D_p(p_n,\widehat{q}^*)(p_n - k(\widehat{q}^*)) + D(p_n,\widehat{q}^*) \\ &\quad + \sum\nolimits_{n'=1}^{N}\left[D_q(p_{n'},\widehat{q}^*)(p_{n'} - k(\widehat{q}^*)) - D(p_{n'},\widehat{q}^*)k'(\widehat{q}^*)\right]\frac{d\widehat{q}^*}{dp_n} = 0.\end{aligned} \tag{25}$$

[26] Again, we suppose here that the incremental profit for each agreement is, for all contingencies, positive.

We consider in each case a symmetric outcome so that $p_n = p$. Note now that when $\gamma = 1$, then this implies from (13) that

$$D_q(p_n, \widehat{q}^*)(p_n - k(\widehat{q}^*)) - D(p_n, \widehat{q}^*)\, k'(\widehat{q}^*) = 0,$$

so that we have indeed $p_M^* = p_R^*$. However, for $\gamma < 1$ note first that, again at the symmetric choice $p_n = p$, it holds (irrespective of who chose p_n) that

$$D_q(p_n, \widehat{q}^*)(p_n - k(\widehat{q}^*)) - D(p_n, \widehat{q}^*)\, k'(\widehat{q}^*) > 0.$$

From this, together with (24) and (25), as well as $\frac{d\widehat{q}^*}{dp_n} > 0$ and using strict quasiconcavity of payoffs also in p_n, we have that $p_M^* > p_R^*$ when $\gamma < 1$.

Finally, in view of the discussion in the main text, suppose that we require that the manufacturer chooses $p_n = p$. Note first that at symmetric prices $p_n = p$, we have that $\frac{d\widehat{q}^*}{dp} = N\frac{d\widehat{q}^*}{dp_n}$ and further that $\frac{d\widehat{q}^*}{dp}$ is simply obtained from

$$\gamma\left[(p - k(\widehat{q}^*))\, D_q(p, \widehat{q}^*)\right] - k'(\widehat{q}^*)D(p, \widehat{q}^*) = 0.$$

With this at hands, the equilibrium condition for $p = p_M^*$ is the same as (25) and can also be rewritten as

$$D_p(p, \widehat{q}^*)(p - k(\widehat{q}^*)) + D(p, \widehat{q}^*) + \left[D_q(p, \widehat{q}^*)(p - k(\widehat{q}^*)) - D(p, \widehat{q}^*)\, k'(\widehat{q}^*)\right]\frac{d\widehat{q}^*}{dp} = 0. \quad (26)$$

For future reference note also again that it is independent of N.

Finally, from (14) we can again define again for any given n (and given prices for all other retailers) $z(p_n, \widehat{q}^*)$, noting that $z_{\widehat{q}^*} < 0$. From implicit differentiation this yields,

$$\frac{d\widehat{q}^*}{dp_n} = \frac{1}{-z_{\widehat{q}^*}}\left[\gamma D_q(p_n, \widehat{q}^*) - k'(\widehat{q}^*)D_p(p_n, \widehat{q}^*) + \gamma\,(p_n - k(\widehat{q}^*))\, D_{pq}(p_n, \widehat{q}^*)\right].$$

Q.E.D.

Proof of Corollary 1. Recall first that, as derived at the end of the proof of Proposition 2, p_M^* is independent of N. Next, note that at symmetric prices $p_n = p$, it holds that $\frac{d\widehat{q}^*}{dp_n} = \frac{1}{N}\frac{d\widehat{q}^*}{dp}$. Together with strict quasiconcavity, the result follows then from comparing (24) with (26). **Q.E.D.**

Proof of Proposition 3. Consider first assertion i) and recall from the proof of Proposition 2 that $p_R^* = p_M^*$ for $\gamma = 1$. Now observe $p_M^* > p_{CS}^*$ at $\gamma = 1$, which follows once we rewrite condition (26) to obtain

$$\begin{aligned} \left.\frac{d\widehat{q}^*}{dp}\right|_{p_M^*} &= \frac{(p - k(\widehat{q}^*)) - (\widehat{q}^* - p)}{(p - k(\widehat{q}^*)) - (\widehat{q}^* - p)\, k'(\widehat{q}^*)} \\ &< 1, \end{aligned}$$

since from (16) $D(p, \widehat{q}^*) > 0$ only if $p < 2k$. This implies also that $\widehat{q}^* < 2k$ and, thus, $k'(\widehat{q}^*) < 1$. The assertion then follows from

$$\begin{aligned} \left.\frac{dCS}{dp}\right|_{p_M^*} &= (\widehat{q}^* - p)\left(\left.\frac{d\widehat{q}^*}{dp}\right|_{p_M^*} - 1\right) \\ &< 0, \end{aligned}$$

together with strict quasiconcavity of CS in p. Next, we can solve explicitly for

$$p_{CS}^* = (1+\gamma)\sqrt{\gamma(2+\gamma)}k - \gamma(2+\gamma)k$$

and

$$p_R^* = \frac{1}{4}\gamma(2+\gamma)k.$$

From this we obtain immediately that

$$\infty = \left.\frac{p_{CS}^*}{d\gamma}\right|_{\gamma=0} > \left.\frac{p_R^*}{d\gamma}\right|_{\gamma=0} = \frac{k}{2}.$$

Hence, we have that $p_{CS}^* > p_R^*$ for small values of γ and $p_{CS}^* < p_R^*$ for large values of γ. In fact, one can even solve in closed form for $\gamma_{CS} = \frac{2}{3}$. Furthermore, note that for $\gamma = 0$ we have $\widehat{q}^* = p$ from (16) and thus, $\left.\frac{d\widehat{q}^*}{dp}\right|_{\gamma=0} = 1$, which in turn implies $\frac{dCS}{dp} = 0$ so that $p_W^* = p_M^*$ and $p_R^* = 0$ for $\gamma = 0$. Hence, we have that $p_W^* > p_R^*$ for small values of γ and $p_W^* < p_R^*$ for large values of γ. Finally, since $W = \pi + CS$, this implies that also $p_M^* > p_W^*$ for all $\gamma > 0$.

Now turn to assertion ii). Recall from the preceding proof of assertion i), that for some value $\gamma_{CS} \in (0,1)$ we have that $CS(p_R^*) = CS(p_{CS}^*) > CS(p_M^*)$ and for $\gamma_W \in (0,1)$, we have that $W(p_R^*) = W(p_W^*) > W(p_M^*)$, respectively, while $CS(p_R^*) = CS(p_M^*)$ and $W(p_R^*) < W(p_M^*)$ for $\gamma = 1$. Hence, it remains to be shown that $CS(p_R^*) < CS(p_M^*)$ and $W(p_R^*) < W(p_M^*)$ at small values of γ. Observe that at $\gamma = 0$, we have $\frac{dCS(p_R^*)}{d\gamma} = \frac{dCS(p_M^*)}{d\gamma} = 0$, but $\frac{d^2CS(p_R^*)}{d\gamma^2} = \frac{1}{4}k^2$ and $\frac{d^2CS(p_M^*)}{d\gamma^2} = \frac{4}{9}k^2$. Finally, we have $\frac{dW(p_R^*)}{d\gamma} = 0$ and $\frac{dW(p_M^*)}{d\gamma} = \frac{8}{27}k^2$ at $\gamma = 0$. **Q.E.D.**

Proof of Proposition 5. With linear demand, expressions (9) and (10) can be further simplified to

$$V_M(N) = \frac{N}{6}\left\{\begin{array}{l} [(3 - 2\delta(N-1))(\widehat{q}^* - p) - \delta(N-1)(q_0 - p_0)](p - k(\widehat{q}^*)) \\ -[(3 - \delta(N-1))(q_0 - p_0) - 2\delta(N-1)(\widehat{q}^* - p)][p_0 - k_0] \end{array}\right\}$$

and

$$
\begin{aligned}
& V_M(N) - V_{Rn}(N) \qquad (27)\\
= \; & \frac{(N+1)}{6} \left\{ \begin{array}{c} \left[\left(\frac{N-1}{N+1}\right)(3 - 2\delta(N-2))(\widehat{q}^* - p) - \delta(N-1)(q_0 - p_0)\right][p - k(\widehat{q}^*)] \\ -[(3 - \delta(N-1))(q_0 - p_0) - 2\delta(N-1)(\widehat{q}^* - p)][p_0 - k_0] \end{array} \right\}.
\end{aligned}
$$

Now observe that from the first-order condition for q_{BR} we obtain with $q_{BR} = \widehat{q} = \widehat{q}^*$ that

$$
\begin{aligned}
& (3 - 2\delta(N-1))[\gamma(p - k(q)) - (\widehat{q}^* - p)k'(\widehat{q}^*)] \\
& + \delta(N-1)[(q_0 - p_0)k'(\widehat{q}^*) + 2\gamma(p_0 - k_0)] \\
= \; & 0.
\end{aligned}
$$

This implies that

$$
\begin{aligned}
& (3 - 2\delta(N-1))[(p - k(\widehat{q}^*)) - (\widehat{q}^* - p)k'(\widehat{q}^*)] \\
\geq \; & -\delta(N-1)[(q_0 - p_0)k'(\widehat{q}^*) + 2(p_0 - k_0)], \qquad (28)
\end{aligned}
$$

whith a strict inequality for $\gamma < 1$. Differentiating (27) with respect to q yields

$$
\begin{aligned}
& \left.\frac{d(V_M(N) - V_{Rn}(N))}{dq}\right|_{\widehat{q}^*} \\
= \; & \frac{(N+1)}{6} \left\{ \begin{array}{c} \left(\frac{N-1}{N+1}\right)(3 - 2\delta(N-2))[p - k(\widehat{q}^*) - (\widehat{q}^* - p)k'(\widehat{q}^*)] \\ +\delta(N-1)(q_0 - p_0)k'(\widehat{q}^*) + 2\delta(N-1)[p_0 - k_0] \end{array} \right\},
\end{aligned}
$$

from which, after substituting (28) and some transformations, we obtain

$$
\begin{aligned}
& \left.\frac{d(V_M(N) - V_{Rn}(N))}{dq}\right|_{\widehat{q}^*} \\
\geq \; & \delta(N-1)\left(\frac{6 - 5\delta(N-1)}{3 - 2\delta(N-1)}\right)[(q_0 - p_0)k'(\widehat{q}^*) + 2(p_0 - k_0)] \\
> \; & 0.
\end{aligned}
$$

The first inequality holds strictly for $\gamma < 1$ and the last inequality follows from $\delta(N-1) < 1$. **Q.E.D.**

References

Bagwell, K. and M.H. Riordan, 1991, High and Declining Prices Signal Product Quality. American Economic Review 81, 224-239.

De Clippel, G. and R. Serrano, 2008, Marginal Contributions and Externalities in the Value, Econometrica 76, 1413-1436.

De Fontenay, C. and J. Gans, 2013, Bilateral Bargaining with Externalities, Journal of Industrial Economics (forthcoming).

Deneckere, R., Marvel, H.P., and J. Peck, 1997, Demand Uncertainty and Price Maintenance: Markdowns as Destructive Competition, American Economic Review 87, 619-641.

Elzinga, K.G. and D.E. Mills, 2008, The Economics of Resale Price Maintenance, in Elzinga, K.G. and D.E. Mills (eds), Issues In Competition Law And Policy (3-Volume Set), ABA Section of Antitrust Law.

Heidhues, P. and B. Kőszegi, 2008, Competition and Price Variation When Consumers Are Loss Averse, American Economic Review, 98, 1245-68.

Hosken, D. D. Reiffen, 2004, Patterns of Retail Price Variation, RAND Journal of Economics 35, 128-146.

In, Y. and J. Wright, 2012, Signaling Private Choices, Mimeo.

Inderst, R. and S. Pfeil, 2013, Securitization and Compensation in Financial Institutions, Review of Finance 17, 1232-1364.

Inderst, R. and C. Wey, 2003, Bargaining, Mergers, and Technology Choice in Bilaterally Oligopolistic Industries, Rand Journal of Economics 34, 1-19.

Klein, B. and K.B. Leffler, 1981, The Role of Market Forces in Assuring Contractual Performance, Journal of Political Economy 89, 615-641.

Klein, B. and K.M. Murphy, 1988, Vertical Restraints as Contract Enforcement Mechanisms, Journal of Law and Economics 31, 265-297.

Leavitt, H.J., 1954, A Note on Some Experimental Findings About the Meanings of Price, Journal of Business 27, 205-210.

Macho-Stadler, I., Perez-Castrillo, D., and D. Wettstein, 2007, Sharing the Surplus: An Extension of the Shapley Value for Environments with Externalities, Journal of Economic Theory 135, 339-356.

Milgrom, P. and J. Roberts, 1986, Price and Advertising Signals of Product Quality, Journal of Political Economy 94, 796-821.

Marvel, H.P. and S. McCafferty, 1984, Resale Price Maintenance and Quality Certification, RAND Journal of Economics 15, 346-359.

Mathewson, F. and R. Winter, 1998, The Law and Economics of Resale Price Maintenance, Review of Industrial Organization 13, 57-84.

Myerson, R.B., 1977a, Graphs and Cooperation in Games, Math. Operations Res. 2, 225-229.

Myerson, R.B.,.1977b, Values of Games in Partition Function Form, International Journal of Game Theory 6, 23-31.

Nakamura, E. and J. Steinsson, 2008, Five Facts about Prices: A Reevaluation of Menu Cost Models, The Quarterly Journal of Economics 123, 1415-1464.

Navarro, N., 2007, Fair Allocations in Networks with Externalities, Games and Economic Behavior 58, 354-364.

Leavitt, H. J., 1954, A Note on Some Experimental Findings about the Meaning of Price, Journal of Business 27, 205-10.

Rao, A. R. and K.B. Monroe, 1989, The Effect of Price, Brand Name, and Store Name on Buyers' Perceptions of Product Quality: An Integrative Review, Journal of Marketing Research 26, 351-357.

Rey, P. and J. Tirole, 1986, The Logic of Vertical Restraints, American Economic Review 76, 921-939.

Romano, R.E., 1994, Double Moral Hazard and Resale Price Maintenance, RAND Journal of Economics 25, 455-466.

Shapiro, C., 1983, Premiums for High Quality Products as Returns to Reputations, Quarterly Journal of Economics 98, 659-679.

Spence, A.M., 1975, Monopoly, Quality, and Regulation, Bell Journal of Economics 6, 417-429.

Telser, L.G., 1960, Why Should Manufacturers Want Fair Trade?, Journal of Law and Economics 3, 86-105.

Wolinsky, A., 1983, Prices as Signals of Product Quality, Review of Economic Studies 50, 647-658.

Zeithaml, V. A., 1988, Consumer Perceptions of Price, Quality, and Value: A Means-End Model and Synthesis of Evidence, Journal of Marketing 52, 2-22.