Upstream market power and product line differentiation in retailing

E. Avenel*& S. Caprice†

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Abstract

We analyze a model of vertical differentiation in which retailers compete in product lines and may purchase a high quality good from a monopolist. The low quality good is produced by a competitive fringe. Depending on quality and cost differentials, the product lines chosen by retailers in equilibrium are either identical, completely different or partially overlapping. In the absence of upstream market power, the unique equilibrium is for retailers to offer identical product lines. Product line differentiation emerges as a result of strategic effects.

Key-words: Product line rivalry, vertical contracting, market power, retailing.

JEL Classification: D43, L13, L42, L81.

1 Introduction

This paper examines the determinants of the product lines offered by competing retailers. One characteristic of retailers is that they generally don't produce the goods they sell, but rather purchase these goods from producers on wholesale markets. Commonly, producers have some market power. As we show, upstream market power impacts on retailers' product line choices. In other words, equilibrium product lines will be different from the product

*GAEL (UMR INRA - Université Pierre Mendès France). E-mail : eric.avenel@upmf-grenoble.fr

†INRA-ESR, Toulouse. E-mail : caprice@toulouse.inra.fr

lines that would obtain with competitive supply on wholesale markets. We know no other paper focusing on this point.

We consider a model of vertical differentiation with two qualities and assume that the high quality is produced by a monopolist, while the low quality is produced by a competitive industry. Consumers are supplied by two identical retailers. Because we focus on demand side aspects of product line differentiation, we assume that each variety is produced at constant marginal cost. In particular there are no economies of scope. We determine the subgame-perfect equilibria of a multi-stage game in which the manufacturer first offers a contract to retailers, then retailers choose their product lines and finally compete on the final market à la Cournot.

In this game of vertical contracting with downstream firms engaged in product line rivalry, the manufacturer chooses its contract offer in order to induce the product lines that are most profitable to it. Depending on cost and quality differentials between the two varieties of the good, this can be either head-to-head competition, complete differentiation or partial differentiation, that is, both retailers sell the low quality good, but only one of them sells the high quality good. The paper provides a complete discussion of the strategic effects at work in the model.

This paper is related to previous work on product line rivalry. Brander and Eaton (1984) define a multi-stage game in which firms first choose their product lines and then compete on the market. There are two pairs of varieties available to firms and Brander and Eaton examine whether firms prefer to operate on a segmented market, each selling one of the two pairs of varieties, or on an interlaced market, each selling one variety of each pair, which leads to tougher competition but can be profitable when firms face entry threats. Champsaur and Rochet (1989) consider a model in which firms offer intervals of qualities to heterogenous consumers and show that in equilibrium it is not in the interest of a firm to offer a quality range that overlaps its competitor's quality range. DeFraja (1996) examines the same issue of whether all the potential varieties are offered. Contrary to Champsaur and Rochet (1989) in which product lines are completely differentiated, in DeFraja (1996) firms compete head-to-head in equilibrium. The difference in outcomes is probably related to the fact that competition on each variety is à la Bertrand in Champsaur and Rochet (1989) and à la Cournot in DeFraja (1996). The issue of whether firms differentiate their product lines or compete head-to-head is addressed in Gilbert and Matutes (1993) in yet another setting in which firms are differentiated by both quality and brand name. All of these contributions implicitly assume that firms purchase their inputs from competitive fringes. While this assumption may be justified for some industries, it is not true for a wide variety of retailing activities.[1] Retailers purchase some varieties of the good, if not all, from producers that enjoy significant market power and are thus in a position to impose contractual conditions to retailers. Of course, the retailer can refuse these conditions but then it will not be able to offer the variety to consumers, a big difference compared with purchasing from competitive industries. In this paper, we examine the implications for product lines of the presence of market power at the manufacturing stage. Dobson and Waterson (1996)

[1] A prominent example is the European car market where car retailers are clearly price takers on the wholesale market. Klemperer (1992) assumes the absence of upstream market power, but takes into account an element that is relevant for the retailing sector, namely the existence of "shopping costs". He shows that while firms would prefer differentiated product lines in the absence of shopping costs, due to Bertrand competition, they may make higher profits with head-to-head competition in the presence of shopping costs.

consider precisely this issue, but they use a very different setting and it is difficult to compare their results with ours. Firstly, they don't consider vertical differentiation, but two-dimensional horizontal differentiation: products are horizontally differentiated, as well as retailers. Secondly, they consider linear pricing on the intermediate market, so that double-marginalization plays a central role in their paper. Firms can sign exclusive dealing contracts and then use monetary transfers. Thus there is a link between exclusive dealing and the resolution of the double-marginalization problem. In contrast, we assume that the manufacturer offers two part tariffs, thus eliminating the double-marginalization issue and introducing rent-sharing effects. Moreover, the manufacturer cannot sign exclusive dealing agreements with retailers. If exclusivity emerges in our model, it is because one of the retailers refuses the contract offered by the manufacturer. Finally, Dobson and Waterson clearly focus on the antitrust aspects of exclusive dealing agreements, while we are primarily interested in the product lines offered by retailers. Introducing exclusive dealing contracts is a possible extension of our model (more on this in the conclusion).

The plan of the paper is as follows: in section 2, we present the model and solve the downstream competition stage of the game; in section 3, we determine the contract offered by the manufacturer in equilibrium and the resulting product lines. Section 4 concludes.

2 The model

We consider an industry with two identical downstream retailers, D_1 and D_2, who buy from an upstream producer ("the manufacturer" in what follows), and a competitive fringe, ("the fringe"). The manufacturer produces a high quality product at constant marginal cost $c \geq 0$ while the competitive fringe produces a low quality product at constant marginal cost of zero. The retailing costs are also zero. Let $q_H = 1$ be the high quality and $q_L = q < 1$ be the low quality. There is a unit mass of consumers, each of whom is interested in buying at most one unit. The utility of consumers is of the Mussa-Rosen (1978) type: each consumer obtains a utility $\theta q_k - p_k$ if he buys one unit of good k, $k = L, H$, where θ is distributed uniformly on the interval $[0, 1]$, and a utility of zero if he does not buy at all. Given consumers' preferences, the demand functions are $Y_H = 1 - \frac{p_H - p_L}{1-q}$ and $Y_L = \frac{p_H - p_L}{1-q} - \frac{p_L}{q}$.

We denote respectively by y_H^i and y_L^i the quantity of the high quality and the low quality product offered by D_i. Inverting demand functions for the two qualities leads to:

$$\begin{cases} p_L = \left(1 - y_H^1 - y_H^2 - y_L^1 - y_L^2\right) q \\ p_H = 1 - y_H^1 - y_H^2 - \left(y_L^1 + y_L^2\right) q \end{cases} \tag{1}$$

We assume that $c \leq 1 - q$.[2]

2.1 The game

The strategic interactions between upstream and downstream firms are represented by a three stage game:

Stage 1: The manufacturer proposes to D_1 and D_2 an identical two-part tariff, $T\left(y_H^i\right) = w y_H^i + F$, $i = 1, 2$.[3]

Stage 2: Retailers simultaneously accept or refuse the contract offered by the manufacturer. If a retailer accepts the contract, it pays the fixed fee at this stage.

[2] This assumption ensures that the high quality will be offered to consumers in equilibrium.

[3] This assumption is discussed in section 3.

Stage 3: Retailers simultaneously choose $(y_H^i, y_L^i)_{i=1,2}$.

Information in this game is both complete and perfect. In particular, contracts are public and cannot be secretly renegotiated.[4] We solve the game by backward induction.

The product lines that will actually be offered depend on the decision of retailers to accept the contract proposed by the manufacturer (stage 2) and to offer the varieties of the good to which they have access (stage 3). In particular, retailers linked to the manufacturer by a contract may choose not to offer the low quality good in stage 3. In the next subsection, we derive the equilibrium outputs of retailers in the stage 3-subgames.

2.2 The downstream Cournot-Nash equilibrium

If both retailers accept the contract in stage 2, they compete on an equal basis in stage 3, since both have access to the low quality good for free and to the high quality good at wholesale price w. Let $y_H(w,w)$, $y_L(w,w)$ be the quantities of high quality good and low quality good offered by each firm in the symmetrical Cournot-Nash equilibrium. We denote by $\pi(w,w)$ the corresponding profit (gross of the franchise fee), that is,

$$\pi(w,w) = p_L y_L(w,w) + (p_H - w)\, y_H(w,w).$$

Lemma 1 *When both firms accept the contract (w,F) in stage 2, $y_H(w,w) = \frac{1-q-w}{3(1-q)}$ and $y_L(w,w) = \frac{w}{3(1-q)}$ for $0 \le w \le 1-q$, $y_H(w,w) = 0$ and*

[4] If we instead assume that contracts are offered secretly or that public offers can be secretly renegotiated, the manufacturer faces a commitment problem, as in Rey and Tirole (2003). Essentially, the manufacturer cannot choose the number of retailers. While supplying only one retailer would maximize its profits, it supplies both retailers, because it cannot commit not to do so. Industry profits are equal to the non-cooperative duopoly profits instead of the monopoly profit. In terms of product lines, there is no differentiation. Nevertheless, if we assume both that contracts are secret and that the manufacturer is able to commit to supply only one firm, supplying only one firm may be an equilibrium. This commitment may be achieved through technology choices.

$y_L(w,w) = \frac{1}{3}$ *for* $w \geq 1-q$.

Proof. This is the Cournot-Nash equilibrium to the sub-game.□

Corollary 1 $\pi(w,w) = \frac{(1-w)^2 - q(1-2w)}{9(1-q)}$ *for* $0 \leq w \leq 1-q$ *and* $\pi(w,w) = \frac{q}{9}$ *for* $w \geq 1-q$.

Note that lemma 1 also describes the outputs that would result in equilibrium if the high quality good was supplied by a competitive fringe producing at constant marginal cost w rather than by an upstream monopolist.

If only one retailer accepts the contract, it is at a competitive advantage in stage 3. Let $y_H(w,N)$, $y_L(w,N)$ be the high quality and low quality output of this retailer, where N denotes no access to the high quality product. We denote by $\pi(w,N)$ the profit of this retailer. The other retailer sells only the low quality good. We denote its output by $y_L(N,w)$ and its profit by $\pi(N,w)$. Profits are given by

$$\pi(w,N) = p_L y_L(w,N) + (p_H - w)\, y_H(w,N) \text{ and } \pi(N,w) = p_L y_L(N,w).$$

Lemma 2 *When only one retailer accepts the contract* (w,F) *in stage 2,* $y_H(w,N) = \frac{2-q-2w}{4-q}$, $y_L(w,N) = 0$, $y_L(N,w) = \frac{1+w}{4-q}$ *for* $0 \leq w \leq \frac{1-q}{3}$, $y_H(w,N) = \frac{1-q-w}{2(1-q)}$, $y_L(w,N) = \frac{3w-(1-q)}{6(1-q)}$, $y_L(N,w) = \frac{1}{3}$ *for* $\frac{1-q}{3} \leq w \leq 1-q$, $y_H(w,N) = 0$, $y_L(w,N) = y_L(N,w) = \frac{1}{3}$ *for* $w \geq 1-q$.

Proof. This is the Cournot-Nash equilibrium to the sub-game.□

Corollary 2

$$(\pi(w,N), \pi(N,w)) = \left(\left(\frac{2-q-2w}{4-q}\right)^2, \left(\frac{1+w}{4-q}\right)^2 q\right) \text{ for } 0 \leq w \leq \frac{1-q}{3},$$

$$(\pi(w,N), \pi(N,w)) = \left(\frac{5q^2 - q(14-18w) + 9(1-w)^2}{36(1-q)}, \frac{q}{9}\right) \text{ for } \frac{1-q}{3} \leq w \leq 1-q,$$

$$\pi(w,N) = \pi(N,w) = \frac{q}{9} \text{ for } w \geq 1-q.$$

Note that the retailer that accepts the contract doesn't necessarily offer the low quality good, although it can get it for free from the competitive fringe. When interbrand competition within the retailer would be too tough, the retailer refuses to offer the low quality good and the differentiation in product line is complete. Note also that when the retailer offers both qualities to consumers, w has an impact on $y_H(w, N)$ and $y_L(w, N)$, but no longer on $y_L(N, w)$. In this situation of partial product line differentiation, the retailer substitutes between the two qualities, but this has no impact on the output of its competitor.

Corollary 2 shows that, for $\frac{1-q}{3} \leq w$, w has no impact on the profit of the retailer not supplied by the manufacturer. Changes in the wholesale price induce changes in the proportion of high and low quality in the output of the supplied retailer, but not its total output. The profit function of the competitor is thus unaffected (see the expression of p_L in (1)). This result is useful for the resolution of stages 1 and 2, since this profit is the reservation profit of a retailer when its competitor accepts the contract.

If both retailers refuse the contract, they compete on the low quality good. In equilibrium, both offer $y_L(N, N)$.

Lemma 3 *When both firms refuse the contract in stage 2,* $y_H(N, N) = 0$ *and* $y_L(N, N) = \frac{1}{3}$.

Proof. Consequence of lemma (1).□

Corollary 3 $\pi(N, N) = \frac{q}{9}$

Having solved the downstream competition game, in the next section we analyze the impact of upstream market power on equilibrium product line differentiation.

3 Vertical contracting equilibrium and product lines

Given our assumption on c and q, the high quality good will be offered on the final market.[5] The issue is whether it will be offered by one or two retailers. This depends on the size of the franchise fee charged by the manufacturer. In any case, the manufacturer chooses F such that retailers' participation constraints are binding. The franchise fee will be set at $F = \pi(w,w) - \pi(N,w)$ when the manufacturer supplies both retailers. We denote by w_{DD} the wholesale price that maximizes the manufacturer's profit in this case. w_{DD} is the solution of $\underset{w}{Max}\Phi(w,w)$, with $\Phi(w,w) = 2\left[(w-c)\, y_H(w,w) + \pi(w,w) - \pi(N,w)\right]$. When the manufacturer supplies only one retailer, the franchise fee will be set at $\pi(w,N) - \pi(N,N)$. Denoting the profit maximizing price by w_D, we have $w_D = Arg\underset{w}{Max}\,\Phi(w,N)$, with $\Phi(w,N) = (w-c)\, y_H(w,N) + \pi(w,N) - \pi(N,N)$. Above this threshold, no retailer accepts the contract. We provide below the expressions of w_D and w_{DD}.

Lemma 4

$$w_D = \begin{cases} 0, \; \textit{if} \; (q \leq \widetilde{q} \textit{ and } c \leq c_0(q)) \;\; \textit{or} \;\; (q \geq \widetilde{q} \textit{ and } c \leq c_a(q)) \\ \frac{2c(4-q)-(2-q)q}{4(2-q)}, \; \textit{if} \; (q \leq \widetilde{q} \textit{ and } c_0(q) \leq c \leq c_a(q)) \\ c, \; \textit{if} \; c \geq c_a(q) \end{cases} \tag{2}$$

$$\textit{where } \widetilde{q} \simeq 0.721, \; c_0(q) = \frac{(2-q)q}{2(4-q)} \textit{ and } c_a(q_L) = \begin{cases} \frac{\sqrt{2-3q+q^2}}{3\sqrt{2}}, \; \textit{if } q \leq \widetilde{q} \\ \frac{(1-q)\sqrt{q}\left(3\sqrt{q}+2\sqrt{2+q}\right)}{3(4-q)}, \; \textit{if } q \geq \widetilde{q} \end{cases}.$$

Proof.

[5] Indeed, the manufacturer can propose a contract that is (weakly) profitable for it and acceptable to retailers. Offering the good at marginal cost without a franchise fee, as a competitive fringe would do, is one such contract.

Given the expressions of $y_H(w,N)$, $\pi(w,N)$ and $\pi(N,N)$ (see lemma 2 and corollaries 2 and 3),

$$\Phi(w,N)=\begin{cases}(w-c)\left(\frac{2-q-2w}{4-q}\right)+\left(\frac{2-q-2w}{4-q}\right)^2-\frac{q}{9} \text{ for } w\in\left[0;\frac{1-q}{3}\right]\\ (w-c)\left(\frac{1-q-w}{2(1-q)}\right)+\frac{5q^2-q(14-18w)+9(1-w)^2}{36(1-q)}-\frac{q}{9} \text{ for } w\in\left[\frac{1-q}{3};1-q\right]\end{cases}$$

Φ is strictly concave on each interval and continuous at $w=\frac{1-q}{3}$. We solve the program on each interval and compare the solutions to determine w_D.□

Figure 1 below plots the threshold values that appear in lemma 4.

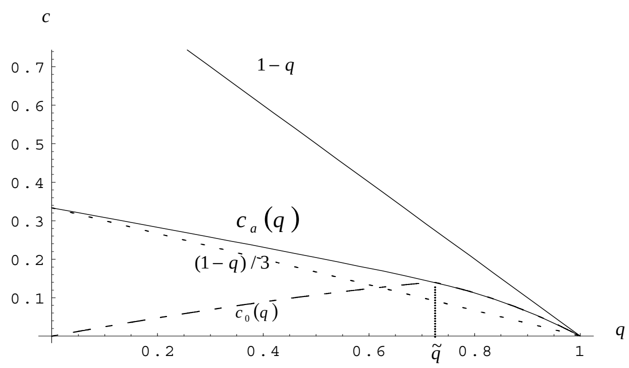

Figure 1: Threshold values when one retailer is supplied

Note that for $c<c_a(q)$, $w_D<c$. Given the nature of downstream competition, precommitment effects give the manufacturer an incentive to charge a wholesale price below marginal cost. The supplied retailer is more aggressive in stage 3 and makes higher profits, since the outputs of retailers are strategic substitutes.[6] Thus, the producer can charge a larger fixed fee. However, there is a trade-off here since selling below c is costly. Lemma 4 shows that this is an optimal strategy for $c<c_a$, but not for $c\geq c_a$.[7]

[6] See Caillaud and Rey (1995) for a discussion of precommitment effects.

[7] Since the retailer's reservation profit is a constant, w_D is the wholesale price that maximizes the joint profits of the manufacturer and the supplied retailer.

Lemma 5

$$w_{DD}=\begin{cases} 0 \quad \textit{for}\ (0\le c\le c_1(q)\ \textit{and}\ q\in[\widehat{q};1]) \\ \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)} \quad \textit{for} \quad \begin{matrix}(0\le c\le c_2(q)\ \textit{and}\ q_L\in[0;\widehat{q}]) \\ \textit{or}\ (c_1(q)\le c\le c_2(q)\ \textit{and}\ q\in[\widehat{q};1])\end{matrix} \\ \frac{1}{4}(1+3c-q) \quad \textit{for}\ c_2(q)\le c\le 1-q \end{cases} \tag{3}$$

where $\widehat{q}=13-3\sqrt{17}\simeq 0.63$, $c_1(q)=\frac{(-16+26q-q^2)(1-q)}{3(4-q)^2}$ *and*
$c_2(q)=\frac{1}{9}\left(-15+3q+2\sqrt{2}\sqrt{32-7q-7q^2}\right)$.

Proof. Given the expressions of $y_H(w,w)$, $\pi(w,w)$ and $\pi(N,w)$ (see lemma 1 and corollaries 1 and 2),

$$\Phi(w,w)=\begin{cases} 2\left[(w-c)\frac{(1-q)-w}{3(1-q)}+\frac{(1-w)^2-q(1-2w)}{9(1-q)}-\left(\frac{1+w}{4-q}\right)^2 q\right] \text{ for } w\in\left[0;\frac{1-q}{3}\right] \\ 2\left[(w-c)\frac{(1-q)-w}{3(1-q)}+\frac{(1-w)^2-q(1-2w)}{9(1-q)}-\frac{q}{9}\right] \text{ for } w\in\left[\frac{1-q}{3};1-q\right] \end{cases}$$

$\Phi(w,w)$ is strictly concave on each interval, continuous at $w=\frac{1-q}{3}$. We solve the program on each interval and compare the solutions to determine w_{DD}.□

Figure 2 below plots the threshold values that appear in lemma 5.

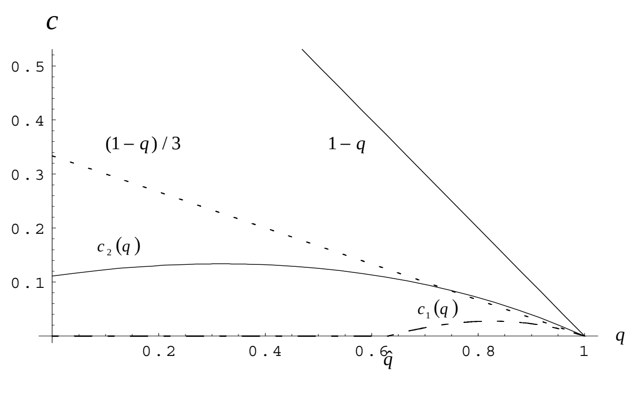

Figure 2: Threshold values when both retailers are supplied

When the manufacturer supplies both retailers, the rent left to each retailer is an increasing function of the wholesale price below $\frac{1-q}{3}$ and a constant above $\frac{1-q}{3}$ (see corollary 2). Since $\frac{1}{4}(1+3c-q) > \frac{1-q}{3}$, while $\frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)} < \frac{1-q}{3}$, lemma 5 shows that for $c \geq c_2$, the manufacturer maximizes the profits of the industry, while for $c \leq c_2$, it distorts the wholesale price, no longer maximizes the profits of the industry, but leaves lower rents to retailers.

The remainder of this section is devoted to the determination of product lines offered by retailers in equilibrium.

Proposition 1 *Equilibrium product lines are as follows:*

(i) If $c \geq c_a$, the manufacturer is indifferent to the number of retailers. If only one retailer is supplied, it sells both qualities and the other retailer sells only the low quality good. If both retailers are supplied, they sell both qualities.

(ii) If $c_b \leq c < c_a$, the manufacturer supplies only one retailer. This retailer provides only the high quality while the other retailer provides only the low quality.

(iii) If $c < c_b$, the manufacturer supplies both retailers. The two retailers either provide only the high quality or both high and low qualities.

The threshold value c_b is a continuous function of q on $[0;1]$ defined by

$$c_b = \begin{cases} \frac{-90+153q-72q^2+9q^3+\sqrt{3}\sqrt{2560-9520q+13112q^2-7290q^3+277q^4+1162q^5-301q^6}}{-42-60q+48q^2} & on\ [0;\overline{\overline{q}}] \\ \frac{(1-q)\sqrt{q}\left(\sqrt{q}\left(-138+51q+6q^2\right)+\sqrt{3}\sqrt{-640+3980q-2140q^2-557q^3+322q^4+7q^5}\right)}{3(-4+q)^3} & on\ [\overline{\overline{q}};1] \end{cases}, \tag{4}$$

where $\overline{\overline{q}} \simeq 0.389$.

Proof. See appendix.□

We plot in figure 3 the threshold values that appear in proposition 1.

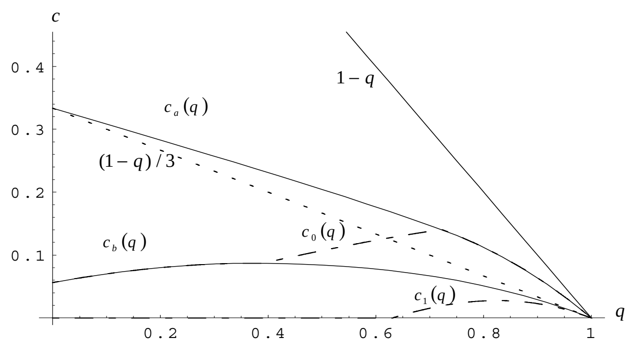

Figure 3: Threshold values in proposition 1

If we compare the equilibrium product lines described in proposition 1 with those that would obtain if retailers purchased both qualities from competitive industries, we see that, along with head-to-head competition, new equilibria appear: partial product differentiation and complete product line differentiation. The partial product line differentiation equilibrium reflects the ability of the manufacturer to replicate the equilibrium where both retailers are supplied by another one in which only one retailer is supplied. In other words, at least for some values of cost and quality parameters, the number of retailers supplied by the manufacturer does not influence the manufacturer's profit. This result is similar to others found in the literature (see, e.g., Rey and Tirole (2003)). However, the complete product line differentiation equilibrium reflects the fact that this indifference result doesn't hold over the whole range of values of the parameters. For some values of cost and quality, the manufacturer is strictly better off when supplying only one retailer. In general, the number of retailers does influence the manufacturer's profits. Because of this, upstream market power has a significant impact not only on prices, but also on the product lines offered by retailers to customers. We provide the intuition for this result below.

For $q = 0$, the arm's length relationship subgame is a special case of the "commitment game" defined by McAfee and Schwartz (1994). They show that in these games the manufacturer's profit is independent of the number of retailers supplied with the high quality good. Proposition 1 shows that this independence result doesn't hold any more when we introduce a second, inferior, but strictly positive quality of the good supplied by a competitive industry ($q > 0$). In particular, in some situations, the manufacturer strictly prefers to supply only one retailer and the differentiation of product lines is complete. The intuition for this result is as follows.

Regardless of the number of retailers it supplies, the manufacturer has to decide whether to charge a wholesale price higher or lower than $\frac{1-q}{3}$. In the first case, it will maximize the profit of the industry and capture it, up to a constant. In the second case, it will distort the wholesale price away from the value that maximizes the profit of the industry in order to commit the supplied retailer to be tough in the final market (if one retailer is supplied) or to reduce the rents left to the retailers (if both retailers are supplied). Note that there is no incentive to distort wholesale prices when $q = 0$ because there is no strategic interaction on the final market when only one retailer is supplied and no rents left to retailers when both are supplied. This is why supplying one or two retailers is equivalent in this case. Optimal prices for $q = 0$ are $w^* = c$ when one retailer is supplied and $w^{**} = \frac{1+3c}{4}$ when both retailers are supplied. The output of high quality good is $\frac{1-c}{2}$ in both cases. Let us consider a very small value $\varepsilon > 0$ of the low quality

q. Because profits are continuous functions of q for any given w, optimal wholesale prices w_D and w_{DD} for $q = \varepsilon$ will be very close to w^* and w^{**} respectively. Distorting wholesale prices to values that are far from w^* and w^{**} cannot be profitable. Let us now examine what this implies for different values of c. First, take $c = \frac{1-\varepsilon}{2}$. Both w^* and w^{**} are clearly above $\frac{1-q}{3}$. This implies that w_D and w_{DD} are also above $\frac{1-q}{3}$. There are no distortions away from the wholesale prices that maximize industry profits and the equivalence between supplying one and two retailers holds. Now, take $c = \frac{1-q}{3}$. w^{**} is still above $\frac{1-q}{3}$, while w^* is equal to $\frac{1-q}{3}$. When supplying both retailers, the manufacturer will charge $w_{DD} = \frac{1-q}{2} > \frac{1-q}{3}$. When supplying one retailer, the manufacturer can obtain the same profits by charging $w = \frac{1-q}{3}$. However, charging w close to $\frac{1-q}{3}$, but strictly lower leads to strictly higher profits, because of the commitment effect. Supplying one retailer is thus strictly better than supplying both retailers. The same argument would apply for any specification of costs and demand such that $w_D = c$ and $w_{DD} > c$ for some value of c. Finally, for $c = 0$, the situation is much more intricate because the manufacturer distorts both in the case when it supplies one retailer and when it supplies both. It turns out that it makes higher profits supplying both retailers. To see the intuition for this result, let us make the further assumption that $q \geq \widehat{q}$. Then, $w_D = w_{DD} = 0$. If the manufacturer supplies only one retailer (say D_1), it gets $\pi(0; N) - \pi(N, N)$. If it supplies both retailers, it gets $2[\pi(0,0) - \pi(N,0)]$. Thus, it supplies both retailers iff

$$\pi(0,0) - \pi(N,0) > \pi(0,N) - \pi(0,0) - [\pi(N,N) - \pi(N,0)]. \qquad (5)$$

The interpretation for this inequality is as follows: The increase in D_2's profit, $\pi(0,0) - \pi(N,0)$, must be larger than the decrease in D_1's profit, $\pi(0,N) - \pi(0,0)$, minus the reduction in the rent left to D_1. Since $\pi(N,N) - \pi(N,0) > 0$, a sufficient condition for (5) to hold is $2\pi(0,0) > \pi(0,N) + \pi(N,0)$.

The results presented in proposition 1 don't critically hinge on the assumption that the manufacturer offers the same contract to both retailers. If we relax this assumption and allow the manufacturer to propose public but discriminatory contracts to retailers, equilibrium wholesale prices and franchise fees will change, but the manufacturer is still not able to replicate monopoly profits.[8] With discriminatory contracts, the manufacturer has four instruments instead of two at its disposal to maximize profits and try to replicate monopoly profits. Even when both retailers offer the high quality good in equilibrium, in general they will pay different wholesale prices to the manufacturer. This contrasts with proposition 1. However, the resolution of the game (not presented here) shows that there are still values of the parameters for which one of the retailers doesn't offer the high quality. These are in fact corner cases in which the contract offered by the manufacturer to one of the retailers is such that it is not accepted or it is accepted but the retailer's equilibrium strategy is not to offer the high quality on the final market. In some cases this will lead to partial product line differentiation, in others to complete product line differentiation. To sum up, what happens when we relax the assumption of non-discriminatory contracts is essentially that instead of switching from completely symmetrical market equilibria to product line differentiation equilibria, market equilibria are in general asymmetrical.

[8] Contracts contingent on the retailers' decisions would allow the manufacturer to replicate monopoly profits. They would also raise serious antitrust concerns.

One of the retailers' high quality offers is less than the other's and in some cases it is zero.

4 Conclusion

In this paper, we analyze product line differentiation between retailers competing on a vertically differentiated market. The specific feature of our model is that we analyze the contractual relations between retailers and manufacturers. As far as we know, this has not been done before. This feature proves to be crucial for the determination of product line differentiation. Indeed, the usual result of irrelevance of the number of retailers supplied for the manufacturer's profit doesn't hold in the situation that we examine. Since product lines depend on the contract offered by the manufacturer, the preferences of the manufacturer as regards the number of retailers offering the high quality good translate into different product lines. Typically, for a given value of the quality differential, when the cost differential is high, the relevance result holds and there are two equilibria, head-to-head competition and partial differentiation. For intermediate and low values of the cost differential, the manufacturer strictly prefers either to supply both retailers, which leads to head-to-head competition, or to supply only one retailer, which leads to complete differentiation.

Our model is specific but provides general insights and can be useful to analyze the retailing of a wide variety of products. A possible extension is to introduce exclusive dealing contracts in the picture. Recall that, in our model, when the manufacturer supplies both retailers, it distorts wholesale prices away from the values that maximize the profit of the industry in order to reduce the rents left to retailers. Because of this distortion, the profit of the industry may be larger when only one retailer is supplied. However, this is not the best strategy for the manufacturer because it would then leave a large rent to the (unique) retailer. Consider an amendment to the model to allow retailers to offer exclusive contracts to the manufacturer. Suppose that industry profits are larger when only one retailer offers the high quality good.[9] The retailers will compete to be the unique retailer. Thus, the rent left to this retailer will be lower and the manufacturer will accept an exclusive dealing contract. Vertical integration may be another way to increase industry profits. Vertical integration differs from exclusive dealing in that it provides enough flexibility to supply non-affiliates and yet favor the affiliate. A vertically integrated retailer may want to supply a limited but positive amount of high quality good to its downstream competitor, who would otherwise purchase more inferior good from the competitive fringe. Thus, vertical integration may be preferred to exclusive dealing.[10] Since these vertical arrangements are relevant, equilibrium product lines may change when introducing them in the model. Indeed, exclusive dealing involves complete product line differentiation, while vertical integration involves partial product line differentiation.[11]

[9] The previous arguments suggest that this assumption is plausible.

[10] However, the drawback of vertical integration as compared to exclusive dealing is that the integrated firm cannot use internal transfer prices to commit to a soft or tough attitude in the final market. Depending on which of the two effects is stronger, one can expect either vertical integration or exclusive dealing in equilibrium. More on this in Avenel and Caprice (2003).

[11] Avenel and Caprice (2003) examine the antitrust issues raised by exclusive dealing and vertical integration in such a framework.

5 Appendix: Proof of proposition 1

It is useful for this proof to define $\Pi(w_D, N) = (w_D - c)\, y_H(w_D, N) + \pi(w_D, N)$ and $\Pi(w_{DD}, w_{DD}) = 2(w_{DD} - c)\, y_H(w_{DD}, w_{DD}) + 2\pi(w_{DD}, w_{DD}) - \pi(N, w_{DD})$. If the manufacturer supplies one retailer, its profit is $\Phi(w_D, N) = \Pi(w_D, N) - \pi(N, N)$. Supplying two retailers, it earns $\Phi(w_{DD}, w_{DD}) = \Pi(w_{DD}, w_{DD}) - \pi(N, w_{DD})$. The proof relies on the comparison between these two expressions. Given that the expressions of w_D and w_{DD} depend on c and q, we consider successively the different domains of values of these parameters.

1. We first take $c > c_a(q)$. Since $c_a(q) > c_2(q)$, $w_D = c > \frac{1-q}{3}$ and $w_{DD} = \frac{1+3c-q}{4} > c > \frac{1-q}{3}$, so that

$$\Pi(w_D, N) = \frac{5q^2 - q(14 - 18c) + 9(1-c)^2}{36(1-q)} \tag{6}$$

and

$$\Pi(w_{DD}, w_{DD}) = 2\left(\frac{1+3c-q}{4} - c\right)\frac{(1-q) - \frac{1+3c-q}{4}}{3(1-q)} + 2\frac{\left(1 - \frac{1+3c-q}{4}\right)^2 - q\left(1 - 2\frac{1+3c-q}{4}\right)}{9(1-q)} - \frac{q}{9} \tag{7}$$

Simplifying the expression of $\Pi(w_{DD}, w_{DD})$ leads to $\Pi(w_D, N) = \Pi(w_{DD}, w_{DD})$.

Moreover, since $\pi(N, w_{DD}) = \frac{q}{9}$ and is thus independent from w_{DD}, it is clear that $\pi(N, N) = \pi(N, w_{DD})$.

We can thus conclude that $\Pi(w_D, N) - \Pi(w_{DD}, w_{DD}) = \pi(N, N) - \pi(N, w_{DD}) = 0$ and consequently $\Phi(w_D, N) = \Phi(w_{DD}, w_{DD})$.

For these values of marginal cost, the manufacturer is indifferent between supplying one or two retailers. There are two equilibria.

2. We then take $c_2(q) < c < c_a(q)$. Since $w_{DD} = \frac{1+3c-q}{4} > \frac{1-q}{3}$, as in the previous case, we have $\pi(N,N) - \pi(N, w_{DD}) = 0$ and $\Pi(w_{DD}, w_{DD})$ is given by the right-hand side of (6).

On the relevant range of values of c and q, c is either larger or lower than $\frac{1-q}{3}$. If $c \geq \frac{1-q}{3}$, then $\Pi(w_{DD}, w_{DD}) = \Pi(c, N)$ (see the previous case). If $c < \frac{1-q}{3}$, then $\Pi(w_{DD}, w_{DD}) < \Pi(c, N)$. Indeed,

$\frac{d}{dc}\left[\Pi(c,N) - \Pi(w_{DD}, w_{DD})\right] = \frac{1}{2} - \frac{4(2-q)}{(4-q)^2} + 2\underbrace{\left[\frac{4}{(4-q)^2} - \frac{1}{4(1-q)}\right]}_{<0} c$, so that

$\frac{d}{dc}\left[\Pi(c,N) - \Pi(w_{DD}, w_{DD})\right] < 0 \Leftrightarrow c > \left[\frac{1}{2} - \frac{4(2-q)}{(4-q)^2}\right] / 2\left[\frac{4}{(4-q)^2} - \frac{1}{4(1-q)}\right]$, which is inferior to c_2. $\Pi(c,N) - \Pi(w_{DD}, w_{DD})$ is thus a decreasing function on $\left[c_2(q); \frac{1-q}{3}\right]$, equal to zero for $c = \frac{1-q}{3}$. Thus $\Pi(c,N) - \Pi(w_{DD}, w_{DD}) > 0$ for $c_2(q) < c < c_a(q)$.

As regards w_D, it is equal either to 0 or to $\frac{2c(4-q)-(2-q)q}{4(2-q)}$. Since these two values maximize $\Pi(w,N)$ (because they maximize $\Phi(w,N)$ and the two functions differ only by a constant) and are different from c, we have $\Pi(w_D, N) > \Pi(c,N)$. Finally,

$$\Pi(w_D, N) - \Pi(w_{DD}, w_{DD}) > \pi(N,N) - \pi(N, w_{DD}) = 0 \tag{8}$$

and

$$\Phi(w_D, N) > \Phi(w_{DD}, w_{DD}). \tag{9}$$

The manufacturer supplies only one retailer. As regards product lines, the retailer that obtains exclusivity offers only the high quality good, whereas the other offers the low quality good. Indeed, both 0 and $\frac{2c(4-q)-(2-q)q}{4(2-q)}$ are inferior to $\frac{1-q}{3}$ for these values of parameters.

3. We finally take $c < c_2(q)$. $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)$ is a piecewise, continuous function of c and q. For each value of q, we show that $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)$ is decreasing in c on each of the relevant subsets of the interval $[0, c_2(q)]$ and determine its sign on the limits of these subsets. This enables us to determine on which subset this function takes the zero value. This leads us to the conclusion that the solution of the equation $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N) = 0$ is a continuous piecewise function, that we denote by $c_b(q)$, such that $c_b \in [c_0; c2]$ on $\left[0; \overline{\overline{q}}\right]$, $c_b \in [0; c_0]$ on $\left[\overline{\overline{q}}; \overline{q}\right]$, $c_b \in [0; c_2]$ on $[\overline{q}; \widehat{q}]$ and $c_b \in [c_1; c_2]$ on $[\widehat{q}; 1]$, where $\overline{q}$ and $\overline{\overline{q}}$ satisfy $\overline{\overline{q}} < \overline{q} < \widehat{q} < \widetilde{q}$. The manufacturer selects only one retailer when $c > c_b(q)$ and two retailers when $c < c_b(q)$.

As regards the expression of $c_b(q)$, numerical methods show that

$$c_b = \begin{cases} \frac{-90+153q-72q^2+9q^3+\sqrt{3}\sqrt{2560-9520q+13112q^2-7290q^3+277q^4+1162q^5-301q^6}}{-42-60q+48q^2} & \text{on } \left[0; \overline{\overline{q}}\right] \\ \frac{(1-q)\sqrt{q}\left(\sqrt{q}\left(-138+51q+6q^2\right)+\sqrt{3}\sqrt{-640+3980q-2140q^2-557q^3+322q^4+7q^5}\right)}{3(-4+q)^3} & \text{on } \left[\overline{\overline{q}}; 1\right] \end{cases} \tag{10}$$

We provide below the details of the third part of the proof.

(a) The first step is to determine the expressions of w_D and w_{DD}. Using the fact that $c_2(q) \leq c_a$, that $c_0 < c_2$ if and only if $q_L < \overline{q}$, with $\overline{q} < \widetilde{q}$ and that $c_1 \leq c_0$ on $[0; 1]$ and $c_1 \geq 0$ iff $q \geq \widehat{q}$, with $\widehat{q} > \widetilde{q}$, we rewrite the expressions of w_D and w_{DD} as follows :

$$(w_D, w_{DD}) = \begin{cases} \left(0, \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)}\right) \text{ for } q \leq \overline{q} \text{ and } 0 \leq c \leq c_0 \\ \left(\frac{2c(4-q)-(2-q)q}{4(2-q)}, \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)}\right) \text{ for } \begin{cases} q \leq \overline{q} \text{ and} \\ c_0 \leq c \leq c_2 \end{cases} \\ \left(0, \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)}\right) \text{ for } \overline{q} \leq q \leq \widehat{q} \text{ and } 0 \leq c \leq c_2 \\ (0, 0) \text{ for } \widehat{q} \leq q \text{ and } c \leq c_1 \\ \left(0, \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)}\right) \text{ for } \widehat{q} \leq q \text{ and } c_1 \leq c \leq c_2 \end{cases} \tag{11}$$

(b) The second step is to study $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)$ on each interval.

For $q \in [\widehat{q}; 1]$ and $c \in [0; c_1]$, $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N) = -2cy_H(0,0) + 2\pi(0,0) - 2\pi(N,0) - (-cy_H(0,N) + \pi(0,N) - \pi(N,N))$

$= -\frac{2+q}{3(4-q)}c + \frac{2+q}{9} - \frac{2q}{(4-q)^2} - \left(\frac{2-q}{4-q}\right)^2.$

This is a decreasing function of c. Numerical calculations show that it is positive for $c = c_1$. As a consequence, $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)$ is positive on $[0; c_1]$ for $q \in [\widehat{q}; 1]$.

For $q \in [\widehat{q}; 1]$ and $c \in [c_1; c_2]$,

$\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N) = 2(w_{DD} - c)\, y_H(w_{DD}, w_{DD}) + 2\pi(w_{DD}, w_{DD}) - 2\pi(N, w_{DD}) - (-cy_H(0,N) + \pi(0,N) - \pi(N,N))$

$= -\left(\frac{4}{9(1-q)} + \frac{2q}{(4-q)^2}\right) w_{DD}^2 + \left(\frac{2}{9} - \frac{4q}{(4-q)^2}\right) w_{DD} - \frac{2+q}{3(4-q)}c + \frac{2}{3}\frac{w_{DD}}{1-q}c + K$ where K is independent from c and $w_{DD} = \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)}$. Deriving this expression with respect to c leads to :

$\frac{d}{dc}[\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)] < 0 \Longleftrightarrow c < \frac{(1-q)q\left(46-17q-2q^2\right)}{(4-q)^3}.$

This condition is satisfied, since for the values of q that we consider, numerical calculations show that $c_2 < \frac{(1-q)q\left(46-17q-2q^2\right)}{(4-q)^3}$. Furthermore, by continuity of $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)$,

$\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)|_{c=c_1} > 0$

and $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)|_{c=c_2} < 0$. For $q \in [\widehat{q}; 1]$, there exists a value $c_b(q)$ which is the unique solution of $\Phi(w_{DD}, w_{DD}) > \Phi(w_D, N)$ iff $c < c_b(q)$.

For $q_L \in [\overline{q}; \widehat{q}]$ and $c \in [0; c_2]$, $\frac{d}{dc}[\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)] < 0 \Longleftrightarrow c < \frac{(1-q)q\left(46-17q-2q^2\right)}{(4-q)^3}$, which is verified, since $c_2 < \frac{(1-q)q\left(46-17q-2q^2\right)}{(4-q)^3}$ on the interval. Furthermore, $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)|_{c=0} > 0$

and $\Phi(w_{DD}, w_{DD}) - \Phi(w_D, N)|_{c=c_2} < 0$.

For $q \in [0;\overline{q}]$ and $c \in [0;c_0]$, $\frac{d}{dc}\left[\Phi\left(w_{DD}, w_{DD}\right) - \Phi\left(w_D, N\right)\right] < 0 \Longleftrightarrow c < \frac{(1-q)q\left(46-17q-2q^2\right)}{(4-q)^3}$ and this condition is also verified, since $c_0 < \frac{(1-q)q\left(46-17q-2q^2\right)}{(4-q)^3}$ (numerical result). Furthermore, numerical calculations show that there exists a value $\overline{\overline{q}} < \overline{q}$ of q such that $\Phi\left(w_{DD}, w_{DD}\right) - \Phi\left(w_D, N\right)\big|_{c=c_0} > 0$ for $q < \overline{\overline{q}}$ and $\Phi\left(w_{DD}, w_{DD}\right) - \Phi\left(w_D, N\right)\big|_{c=c_0} < 0$ for $\overline{\overline{q}} < q < \overline{q}$. We calculated $\overline{\overline{q}} \simeq 0.389$. Finally, $\Phi\left(w_{DD}, w_{DD}\right) - \Phi\left(w_D, N\right)\big|_{c=0} > 0$ (numerical result).

For $q \in \left[0;\overline{\overline{q}}\right]$ and $c \in [c_0;c_2]$, the expression of $\Phi\left(w_D, N\right)$ is modified. Since $w_D < \frac{1-q}{3}$, $\Phi\left(w_D, N\right) = \left(w_D - c\right)\left(\frac{2-q-2w_D}{4-q}\right) + \left(\frac{2-q-2w_D}{4-q}\right)^2 - \frac{q}{9}$. We show that $\frac{d}{dc}\left[\Phi\left(w_{DD}, w_{DD}\right) - \Phi\left(w_D, N\right)\right] < 0 \Longleftrightarrow c < \frac{30-51q+24q^2-3q^3}{2(7+10q-8q^2)}$.

Numerical methods show that the right-hand side is above c_2 on $[0;1]$. The function is thus decreasing on the interval. By continuity, it takes negative values for $c = c_2$ and positive values for $c = c_0$.

Finally, the case $q \in \left[\overline{\overline{q}};\overline{q}\right]$ and $c \in [c_0;c_2]$ is similar to the previous one, except for the fact that $\Phi\left(w_{DD}, w_{DD}\right) - \Phi\left(w_D, N\right)$ takes negative values for $c = c_0$.

To sum up, the number of supplied retailers, the wholesale price and the resulting product lines are as follows :

For $\widehat{q} \leq q$ and $0 \leq c \leq c_1$, the manufacturer supplies both retailers and charges $w_{DD} = 0$. The retailers distribute only the high quality good.

For $q \leq \widehat{q}$ and $0 \leq c \leq c_b$ or $\widehat{q} \leq q$ and $c_1 \leq c \leq c_b$, the manufacturer supplies both retailers and charges $w_{DD} = \frac{-16-3c(-4+q)^2+42q-27q^2+q^3}{2(-32+7q+7q^2)}$. The retailers distribute both qualities.

For $c_b < c \leq c_a$, the manufacturer supplies only one retailer and charges $w_D = 0$ for $c \leq c_0$, $w_D = \frac{2c(4-q)-(2-q)q}{4(2-q)}$ for $c \geq c_0$. In both cases, product line differentiation is complete, i.e. one retailer sells the high quality good and the other sells the low quality good, since both 0 and $\frac{2c(4-q)-(2-q)q}{4(2-q)}$ are less than $\frac{1-q}{3}$ for the values of c and q considered.

For $c_a < c$, the manufacturer is indifferent between supplying one retailer, with $w_D = c$, or two retailers, with $w_{DD} = \frac{1+3c-q}{4}$. If the manufacturer supplies only one retailer, this results in partial product line differentiation: the supplied retailer sells both qualities and the other retailer sells the low quality good. Indeed, $w_D > c_a > \frac{1-q}{3}$.$\square$

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