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Price and non-price restraints
when retailers are vertically differentiated*

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Abstract

We consider vertical restraints in the context of an intrabrand competition model in which a single manufacturer deals with two vertically differentiated retailers. We establish two main results. First, in markets that cannot be vertically segmented, the manufacturer will foreclose the low quality retailer provided that the cost difference between the two retailers is not too large, either directly by making the high quality retailer an exclusive distributor, or indirectly by imposing a sufficiently high minimum resale price, or a sufficiently high franchise fee to ensure that the low quality retailer will be unable to earn a positive profit. Second, in markets that can be vertically segmented, the manufacturer will impose customer restrictions and require the low (high) quality retailer to serve consumers whose willingness to pay for quality is below (above) some threshold. We show that this restriction benefits the manufacturer as well as consumers with low willingness to pay for quality, including some that are served by the high quality retailer, but it harms consumers with high willingness to pay.

Keywords: vertical restraints, exclusive distribution, vertical foreclosure, resale price maintenance customer restrictions

JEL Classification Numbers: L42, K21

1. Introduction

Vertical restraints in the relationship between manufacturers and distributors or retailers, such as resale price maintenance (RPM), exclusive territories, and customer restrictions are the subject of an ongoing legal and academic debate. On one side of the debate, advocates of the Chicago school like Bork (1978) and Easterbrook (1984) argue that the main purpose of vertical restraints is improve the efficiency of vertical relationships and hence should pose no antitrust concerns. On the other side of the debate, those like Baxter (1984), Pitofsky (1978, 1983), and Comanor and Frech (1985) discount the welfare enhancing properties of vertical restraints and emphasize their potential anticompetitive effects. Traditionally, the courts in the U.S. have treated price restraints as per se illegal, while the treatment of non-price based restriction has varied sharply over the years, thereby reflecting the lack of consensus regarding the competitive effects of these practices.¹

In this paper we study the role of vertical restraints in the context of an intrabrand competition model with a single manufacturer and two vertically differentiated retailers facing a continuum of potential consumers with varying degrees of willingness to pay for service quality. This setting is motivated by the observation that in practice, retailers often differ from one another with respect to either their cum-sale services like a highly trained sales staff, technical advice, demonstrations (e.g., fitting rooms for cloths or listening rooms for stereo), ambient atmosphere (often shopping has a consumption value so ambiance enhances consumers' utility), quick delivery, and convenient financing plans, or their post-sale services like extended in store warranties, generous return policies, and reliable maintenance and repair services. We treat the quality of the retailers' services as exogenous. This assumption is appropriate in many environments. For instance, if retailers sell many products (e.g., are large department stores) then the quality of their services is not directly related to any specific product. Likewise, the quality of service may reflect the nature of the retailer's business: a retailer who sells through a catalogue or a web site

¹ The per se illegality of price restraints was first established by the U.S. Supreme court in 1911 in the *Dr. Miles Medical Co. v. John D. Park Sons Co.* 220 U.S. 373 (1911). In recent years the Court has progressively narrowed the scope of the per se illegality rule in the *Monsanto Co. v. Spray-Rite Service Corp.* 465 U.S. 752, 761 (1984) and in *Business Electronics Corp. v. Sharp Electronic Corp.* 485 U.S. 717, 724 (1988); in *State Oil Co. v. Khan*, 66 L.W. 4001 (1997), the Court declared that maximum RPM should be judged under the rule of reason. With regard to non-price restraints, the Court has ruled in 1967 in the *United States v. Arnold Schwinn & Co.* 388 U.S. 365 that territorial restrictions were also illegal per se, but reversed this decision in 1997 in *Continental T.V. Inc. v. GTE Sylvania* 433 U.S. 36. For excellent surveys of the law and economics of vertical restraints, see Mathewson and Winter (1985, 1998), and Comanor and Rey (1997). A historical perspective on the legal treatment of RPM in the U.S. is offered in McCraw (1996).

cannot provide a direct technical advice and demonstrations, while a discount retailer may lack trained staff, demonstrations, or ambiance by design in order to keep costs low.

We establish two main results. The first result concerns anonymous markets in which consumers cannot be identified according to their willingness to pay for quality. We show that so long as the cost difference between the two retailers is not too big (in the sense that if both services are offered at marginal costs, all consumers who wish to buy will prefer the high quality service), it is optimal for the manufacturer to foreclose the low quality retailer. This can be achieved by either (i) making the high quality retailer an exclusive distributor, (ii) imposing an RPM, or (iii) setting a sufficiently high franchise fee. Although the foreclosure of the low quality retailer means that only the high end of the market is served, the absence of competition from a low quality retailer enables the high quality retailer to earn higher profits, which in turns allows the manufacturer to charge a higher franchise fee.² The manufacturer's ability to foreclose the low quality retailer by setting a sufficiently high franchise fee suggests that vertical restraints like exclusive distribution agreements or RPM are not used, in the context of our model, with the sole purpose of foreclosing low quality retailers and hence should not be condemned on that basis alone.³

The foreclosure result provides a new explanation for why manufacturers often refuse to deal with low quality, discount retailers. There are many examples for this practice. Mathewson and Winter (1985) report that in the 1970s, H.D. Lee of Canada refused to deal with Army and Navy stores that were known for their low prices and low services. Greening (1984) reports that in the 1970s, Florsheim shoes attempted to secure exclusive dealings with medium to high quality specialty retailers that kept a full line inventory and provided ample sales clerk assistance, good return policies, and a high level of ambiance

² A similar point has been made in a 1970 report on *Refusal to Sell* by the U.K. Monopolies and Mergers Commission cited in Utton (1996), according to which, "...a supplier may estimate that he does better by catering for a limited class of customer who will pay for exclusiveness than by extending his outlets and risking the loss of his exclusive trade."

³ Traditionally, the legal standard in the U.S. has been that an outright refusal to deal does not violate antitrust law so long as it is unilateral: "a manufacturer of course generally has a right to deal, or refuse to deal, with whomever it likes, as long as it does so independently," *Monsanto Co. v. Spray-Rite Service Corp.*, 465 U.S. 752, 104 S. Ct. 1464, 1469, 79 L. Ed. 2d 775 (1984); *United States v. Colgate & Co.*, 250 U.S. 300, 307, 63 L. Ed. 992, 39 S. Ct. 465 (1919). Recently however, the Supreme Court of the U.S. has qualified this standard in *Eastman Kodak Co. v. Image Service Inc.* 504 U.S. 451 (1992) by ruling that a firm's right to refuse to deal "is not absolute, and it exists only if there are legitimate competitive reasons for the refusal." For a criticism of this ruling and an economic analysis of refusals to deal, see Carlton (2001).

(which Florsheim viewed as an important element of the package it offered to customers). Moreover, Florsheim tried to prevent its retailers from raising or lowering their prices during the regular non-clearance sale period. Utton (1996) reports that manufacturers of fine fragrances (expensive brand name perfumes) in the UK refused to sell to certain retailers like Tesco and Superdrug on the grounds that they failed to meet special standards of display, service, and ambiance (an important factor in the sale of fine fragrances). In addition, the manufacturers established recommended prices for their products which most leading authorized retailers followed. And, in a recent antitrust case, Xerox Corporation was sued, among other things, for refusing to sell copier parts to independent service organizations (ISOs).⁴ Xerox viewed the ISOs as a competitive threat in the copier service market, and viewed the quality of its own service as superior to that of the ISOs due to its ability to locate and deliver any part overnight, and due to the high skills and training level of its technicians.⁵ Our model suggests that in all of these cases, manufacturers may have refused to deal with low quality retailers in order to boost their overall profits by preventing consumers from switching to less profitable low quality services.⁶

⁴ See *Creative Copier Services v. Xerox Corp.*, civil action no. MDL-1021, United States District Court for the District of Kansas, 85 F. Supp. 2d 1130, 2000 U.S.

⁵ Other examples for foreclosure of low quality discount retailers include *Bostick Oil Company, Inc., v. Michelin Tire Corporation, Commercial Division*, No. 81-1985, U.S. Court of Appeals for the 4th circuit, 702 F.2d 1207 (1983) (Michelin terminated Bostick as a distributor of its truck tires after Bostick began to ship tires directly to customers without providing any initial mounting or other service and at prices much below those charged by other Michelin dealers), *Glacier Optical, Inc. v. Optique du Monde, Ltd., and Safilo America, Inc.*, Civil No. 91-985-FR, U.S. District Court for the District of Oregon, 816 F. Supp. 646, (1993) (Glacier was terminated as a distributor of Ralph Lauren/Polo eyewear for Optique du Monde (ODM) after selling eyewear to discount warehouses, like Costco, Shopko, and Wal-Mart that did not provide optometrists', ophthalmologists', or opticians' services and at prices below ODM's suggested resale price list), and *Pants 'N' Stuff Shed House, Inc., v. Levi Strauss & Co.*, No. CIV-84-1375T, U.S. District Court for the Western District of NY, 619 F. Supp. 945, (1985), (Levi's refused to deal with Pants 'N' Stuff on the grounds that it violated Levi's long-standing policy of selling only to retailer customers of suitable quality and against wholesaling its products).

⁶ There are other explanations for why manufacturers may refuse to deal with low quality retailers. Mathewson and Winter (1984) argue that the Lee case is consistent with Telser's (1960) special services hypothesis and with Marvel and McCafferty's (1984) quality certification hypothesis, and Greening (1984) argues that Florsheim's RPM and dealer selection can be best explained by the firm's desire to efficiently signal the high quality of its shoes to customers. Morita and Waldman (2000) argue that by monopolizing the service market for durable goods like copier machines, a manufacturer can induce consumers to make optimal decisions on whether to maintain or replace their used machines (without monopolization, consumers tend to maintain their machines even if it is socially more efficient to replace them). We view these explanations and ours as complementary rather than mutually exclusive.

The second main result of the paper concerns markets in which consumers can be vertically segmented according to their willingness to pay for quality. We show that in these markets, the manufacturer will impose customer restrictions by requiring the low quality retailer to serve consumers whose willingness to pay for quality is below some threshold while requiring the high quality retailer to serve consumers whose willingness to pay for quality is above the threshold. For example, the manufacturer can assign one retailer to serve consumers who buy through mail orders, and assign another retailer to serve consumers who shop at stores. Other types of vertical segmentation of customers can be done on the basis of businesses vs. individuals, small businesses vs. large corporations, and the private sector vs. the government. According to Caves (1984), customer restrictions have been present in mechanics' tools and truck markets, passenger automobiles, drugs, and lightbulbs. This kind of restrictions is also common in cosmetics and hair products and in newspaper distribution.⁷ As far as we know, our paper provides the first formal analysis of customer restrictions.

From the manufacturer's point of view, customer restrictions have two benefits: first they shield the high quality retailer from competition from the low quality retailer (without the restriction some of the high quality retailer's consumers would have switched to the low quality retailer). Consequently, unlike exclusive distribution or RPM, customer restrictions lead to a dual distribution system whereby the manufacturer deals with both retailers rather than just with the high quality retailer. These results suggest that contrary to the common presumption of courts in the U.S., customer restrictions may have very different competitive effects than exclusive distribution agreements.⁸ The difference between the two

⁷ Clairol Inc. marketed hair coloring "salon" products through distributors to beauty salons and beauty schools, and sold a separate "retail" product through large retail chains or wholesalers. Clairol did not allow the beauty salons and beauty schools to sell its "salon" products to the general public (see *Clairol, Inc. v. Boston Discount Center of Berkeley, Inc. et al.*, U.S. Court of Appeals, Sixth Circuit, 608 F.2d 1114 (1979)). Similar customer restrictions were imposed by Wella and Jhirmack (see *Tripoly Co. Inc. v. Wella Corp.* U.S. Court of Appeals, Third Circuit, 425 F.2d 932 (1970)) and *JBL Enterprises, Inc., et al., v. Jhirmack Enterprises, Inc., et al.*, 509 F. Supp. 357, (1981)). The Washington Post Company, distributed its newspapers through a dual system of independent dealers; one group of dealers served home subscribers, and the other, single sales outlets. The company required each dealer to confine his sales to a prespecified area and class of customer. In particular, home delivery dealers were barred from selling to single-copy sales outlets like hotels, newsstands, drug and convenience stores, and street vending machines (see *Alfred T. Newberry, Jr., et al., v. The Washington Post Co.*, 438 F. Supp. 470, (1977)).

⁸ Customer restrictions were first examined by U.S. courts in *White Motor Co. v. United States* 372 U.S. 253 (1963). White Motor Co. was accused of imposing exclusive territories and of preventing its ordinary distributors from selling its trucks to public customers, such as Federal or state government agencies. The Supreme Court treated both practices under the rule of reason. In *Continental T.V. Inc. v. GTE Sylvania* 433 U.S. 36 (1977), the Supreme Court addressed customer and territorial restrictions

restraints stems from the fact that customer restrictions segment the market vertically while exclusive distribution agreements segment the market horizontally. The second benefit of customer restrictions is that they force the high quality retailer to focus on the high end of the market and therefore raise its retail price (without the restriction the high quality retailer would charge a lower price to boost its market share). This in turn benefits the manufacturer because it makes it possible to discriminate between consumers with low and high willingness to pay for quality. Although customer restrictions eliminate competition between the two retailers, they nonetheless benefits consumers with a relatively low willingness to pay for quality, including some who are served by the high quality retailer, but harms consumers at the top end of the market. The mixed welfare results indicate that it is justified to apply the rule of reason in cases that involve customer restrictions.

Most of the literature on vertical restraints has focused on the case where retailers are horizontally differentiated (see for example the literature surveys in Mathewson and Winter, 1985; Ch. 4 in Tirole, 1988; and Katz, 1989). Notable exceptions are Bolton and Bonanno (1988) and Winter (1993). Bolton and Bonanno (1988) consider a model with one manufacturer and two retailers who can choose the quality of their services. They show that although RPM and franchise fees are more profitable than a uniform wholesale price, they do not restore the profits under vertical integration. Winter (1993) considers vertical restraints in a model with both vertical and horizontal differentiation. In his model, a manufacturer deals with two retailers located at the opposite ends of a line segment and can choose the quality of their services which is associated with the speed with which consumers can purchase the product. Winter shows that RPM and Exclusive Territories implement the vertical integration outcome. In both papers, the retailers can choose their quality of service, so unlike in our paper, there is no foreclosure in equilibrium. Moreover both papers do not consider customer restrictions and are mainly interested in whether vertical restraints are sufficient for replicating the vertical integration outcome.

The rest of the paper is organized as follows: in Section 2 we describe the model. Then in Section 3 we solve for the vertical integration outcome; this outcome serves as a useful benchmark because it characterizes the optimal outcome from the manufacturer's view point. In Section 4 we consider markets that cannot be segmented vertically according to the willingness of consumers to pay for quality. We show that in these markets the manufacturer may be able to replicate the vertically integrated outcome by using two part tariffs, exclusive distribution agreements, or imposing RPM. In Section 5 we study

and ruled that: "In both cases the restrictions limited the freedom of the retailer to dispose of the purchased products as he desired. The fact that one restriction was addressed to territory and the other to customers is irrelevant to functional antitrust analysis."

customer restrictions in markets that can be vertically segmented. In section 6 we offer concluding remarks. All proofs are in the Appendix.

2. The model

Consider a manufacturer who produces a single product. The manufacturer does not have the capability to sell the product directly to consumers and needs to rely on downstream retailers. There are two downstream retailers, one that provides a high quality service and is referred to as retailer H and another that provides a low quality service and is referred to as retailer L. The services that the retailers provide are either cum-sales services (highly trained sales staff, technical advice, demonstrations, ambient atmosphere, quick delivery, and convenient financing plans), or post-sale services (extended in store warranties, generous return policies, and reliable maintenance and repair services).

We assume that there is a continuum of potential consumers with a total mass of one, each of whom buys at most one unit. Consumers differ from one another with respect to their marginal valuations of quality. Following Mussa and Rosen (1978), we assume that given the retail prices p_H and p_L set by retailers H and L, the utility of a consumer whose marginal valuation of quality is θ is given by

$$U(\theta) = \begin{cases} S\theta - p_H, & \text{buy from H,} \\ \gamma S\theta - p_L, & \text{buy from L,} \\ 0, & \text{otherwise,} \end{cases} \quad (1)$$

where $S > 0$ and $0 < \gamma < 1$. The parameter γ measures the degree to which the two services are differentiated, with lower values of γ being associated with a greater degree of vertical differentiation.

In what follows, we shall refer to θ as the consumer's type. We assume that consumers' types are drawn from a smooth distribution function $f(\theta)$ on the interval $[\underline{\theta}, \bar{\theta}]$, where $0 \leq \underline{\theta} < \bar{\theta} \leq \infty$, with a cumulative distribution function $F(\theta)$. In addition, we also assume that the distribution of types has a monotone hazard rate in the sense that $(1-F(\theta))/f(\theta)$ is nonincreasing; this assumption is satisfied by many standard continuous distributions (e.g., uniform, exponential, and normal), and it ensures that the second order conditions for the different maximization problems that we consider below are satisfied.

Apart from their different qualities of service, the two retailers may also differ with respect to their cost of service: the per unit costs of retailers H and L are c_H and c_L , where $c_L \leq c_H < \bar{\theta}S$. The assumption that $c_L \leq c_H$ is natural and reflects the idea that the higher quality service may be more costly. The assumption that $c_H < \bar{\theta}S$ ensures that both services are viable because it implies that at least at the top end of the market there are consumers who may wish to buy the high quality service at marginal cost (since

$c_L \leq c_H$, these consumers certainly wish to buy the low quality service at marginal cost).

In order to characterize the demands for the two services, we illustrate in Figure 1 the utilities of consumers if they buy from retailers L and H. In panel (a) we show the case where $p_H \leq p_L/\gamma$. Then, all consumers who get a positive utility from buying are better-off buying from retailer H. Hence, only retailer H operates in the market and serves all consumers with $\theta > p_H/S$. In panel (b) we show the case where $p_H > p_L/\gamma$. Now consumers with $\theta \geq (p_H - p_L)/(1-\gamma)S$ buy from retailer H, consumers with $\theta \in (p_L/\gamma S, (p_H - p_L)/(1-\gamma)S)$ buy from retailer L, and consumers with $\theta \leq p_L/\gamma S$ do not buy at all. Denoting by θ_H the lowest type of consumer served by retailer H and by θ_L the lowest type of consumer served by retailer L, it follows from Figure 1 that the demands faced by the two retailers are

$$Q_H = 1 - F(\theta_H), \quad Q_L = \text{Max} \{ F(\theta_H) - F(\theta_L), 0 \}, \quad (2)$$

where

$$\theta_H \equiv \text{Max} \left\{ \frac{p_H - p_L}{(1-\gamma)S}, \frac{p_H}{S} \right\}, \quad \theta_L \equiv \frac{p_L}{\gamma S}. \quad (3)$$

3. The vertical integration benchmark

In this section we consider the benchmark case in which the manufacturer is vertically integrated with the two retailers. The manufacturer then sets the prices, p_H and p_L , for the high and the low quality services. Using equation (2), the manufacturer's profit under vertical integration is:

$$\pi^{VI} = \begin{cases} (1 - F(\theta_H))(p_H - c_H) + (F(\theta_H) - F(\theta_L))(p_L - c_L), & p_H > p_L/\gamma, \\ (1 - F(\theta_H))(p_H - c_H), & p_H \leq p_L/\gamma. \end{cases} \quad (4)$$

We are now ready to establish the following result (the proof, like all other proofs, is in the Appendix).

Proposition 1: *Suppose that the manufacturer is vertically integrated with the two retailers. Then, the manufacturer offers*

- (i) *only the high quality service if $c_H \leq c_L/\gamma$,*
- (ii) *both services if $c_L/\gamma < c_H < c_L + (1-\gamma)S\bar{\theta}$,*
- (iii) *only the low quality service if $c_H \geq c_L + (1-\gamma)S\bar{\theta}$.*

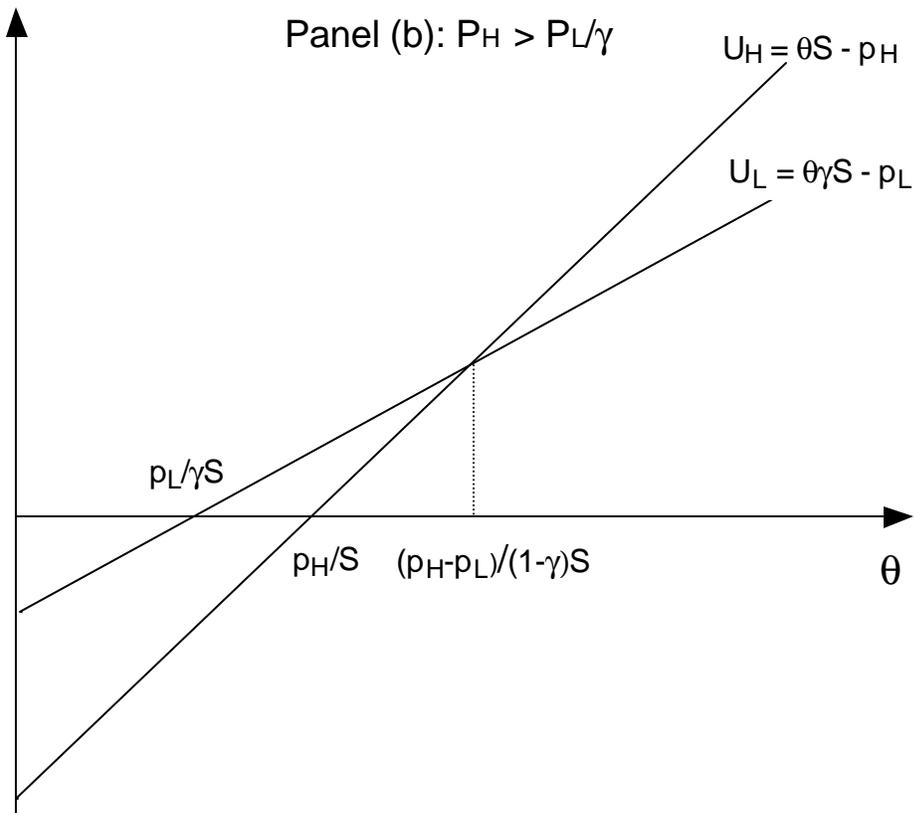
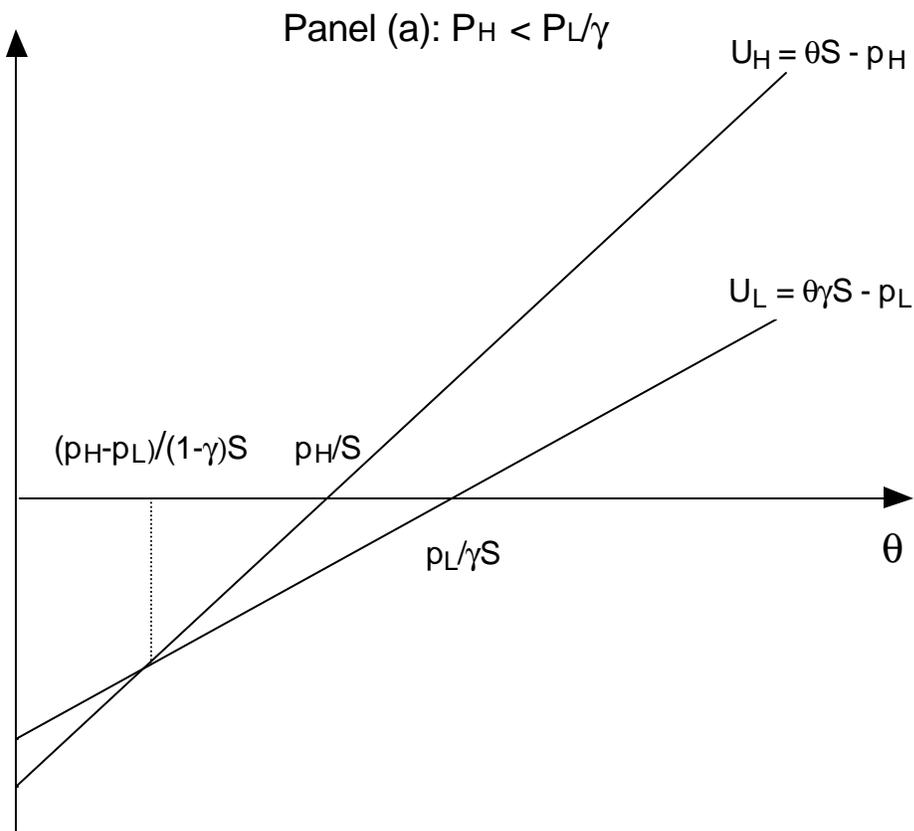


Figure 1: The utility of consumers if they buy from retailers L and H

To interpret Proposition 1, note that the vertically integrated manufacturer faces the following trade-off: by offering both services the manufacturer can discriminate between high and low type customers and charge the former a high price without losing the business of the latter. But, once the low quality service is offered, some high type customers who will otherwise buy the high quality service will now switch to the low quality service. Hence, the manufacturer will not be able to extract as much money from these consumers as in the case where only the high quality service is offered. Proposition 1 shows that which effect dominates depends only on the relationship between c_H and c_L/γ (i.e., the cost-quality ratios of the two services). Intuitively, note that if both services are offered at marginal costs, consumers with $\theta > c_H/S$ obtain a positive utility from buying the high quality service and consumers with $\theta > c_L/\gamma S$ obtain a positive utility from buying the low quality service. If $c_H \leq c_L/\gamma$, then all consumers who wish to buy, prefer the high quality service over the low quality service. Proposition 1 reveals that in this case, a vertically integrated manufacturer will only offer the high quality service. The low quality service is not offered to prevent consumers from switching away from the more profitable high quality service. The situation is completely reversed when $c_H \geq c_L + (1-\gamma)\bar{\theta}S$. Then, the cost difference between the two services is so large that all consumers prefer the low quality service if both services are offered at marginal costs. Now the low quality service is more profitable so the manufacturer does not offer the high quality service to prevent consumers' switching. In the intermediate case where $c_L/\gamma < c_H < c_L + (1-\gamma)\bar{\theta}S$, consumers with $\theta \in [c_L/\gamma S, (c_H - c_L)/(1-\gamma)S]$ prefer to buy the low quality service when both services are offered at marginal costs, while consumers with $\theta > (c_H - c_L)/(1-\gamma)S$ prefer to buy the high quality service. In this case, the manufacturer offers both services and thereby engages in second degree price discrimination.

In what follows we will assume (unless stated otherwise) that $c_H \leq c_L/\gamma$. We choose to focus attention on this case because the salient feature of vertical differentiation (and what distinguishes it from horizontal differentiation) is that if products/services are equally priced, all consumers rank them in the same way. However when $c_L < c_H$, the two services can no longer be always priced the same, so the assumption that $c_H < c_L/\gamma$ seems like a natural way to preserve the unanimity of consumers regarding the ranking of the two services.⁹

Before proceeding, we would like to relate Proposition 1 to existing results in the literature. First, it is well-known that a monopoly may sometimes prefer to provide only a high quality product rather than both high and low quality products (see e.g., the example in Mussa and Rosen, 1978). Proposition 1

⁹ The assumption that $c_H < c_L/\gamma$ is analogous to Condition (F) in Shaked and Sutton (1983) which is necessary and sufficient for the "finiteness property" that says that a vertically differentiated industry with free entry can have a finite number of active firms.

establishes the precise conditions under which this is the case for any distribution of consumers' types that has a monotone hazard rate. In particular, Proposition 1 establishes that when $c_L = c_H$, a vertically integrated manufacturer will only offer the high quality service irrespective of how wide is the support of the distribution of consumers' types (we only require that $\bar{\theta} > c_H/S$). This result is in contrast with Bolton and Bonanno (1988) and Gabszewicz et al (1986), where a vertically integrated manufacturer with $c_L = c_H = 0$ offers only a high quality service when the support of distribution of consumers' types is relatively narrow, but otherwise offers both high and low quality services.¹⁰ The reason for the difference is that while we assume that consumers' preferences are of the Mussa and Rosen (1978) type (see equation (1)), Bolton and Bonanno and Gabszewicz et al assume that consumers' preferences are of the Gabszewicz and Thisse (1979) type, where the utility of a θ type consumer who buys quality q at a price p is $U(\theta) = q(\theta-p)$.¹¹ With these preferences and no retail costs, the benefit from introducing both qualities and discriminating between high and low types consumers outweighs the cost of inducing some high type customers to switch to the low quality service, if and only if the range of consumers' types is sufficiently wide. In our model in contrast, if $c_L = c_H$, then the second negative effect always dominates so the manufacturer will never offer both services, no matter how wide is the range of consumers' types.¹²

¹⁰ In Gabszewicz et al, the manufacturer can offer $n \geq 2$ quality levels. They show that if the support of the distribution of consumers' types is sufficiently wide, the manufacturer offers all n quality levels; otherwise the manufacturer offers only the highest available quality.

¹¹ In other words, in our model the preferences of consumers are quasi-linear in income with θ representing the marginal utility of quality, whereas in Bolton and Bonanno they are Cobb-Douglas with θ representing the consumers' income, so $\theta-p$ represents the expenditure on "all other goods" while q is the utility from the consuming the good in question.

¹² If retail costs are introduced into the Bolton and Bonanno model, then a vertically integrated manufacturer may no longer offer both qualities, even if the support of consumers' type is "sufficiently" wide. To see that, note that Bolton and Bonanno assume that the utility of a type θ consumer is $x(\theta-p_H)$ if the consumer buys a high quality product, $y(\theta-p_L)$ if the consumer buys a low quality product, and $U_0\theta$ if the consumer does not buy, where $x > y > U_0 > 0$, and θ is distributed uniformly on the unit interval (the assumption that the lower bound of the support is 0 ensures that the support is "sufficiently" wide). Given these expressions, the lowest types served by retailers L and H, respectively, are $\theta_L = yp_L/(y-U_0)$ and $\theta_H = (xp_H-yp_L)/(x-y)$. If the manufacturer offers both services, the resulting optimal prices are

$$p_H^* = \frac{y(x - U_0)(2 - c_L) + (2x + y - U_0)c_H}{U_0(x - y) + y(3x + y)}, \quad p_L^* = \frac{(y - U_0)(x + y + xc_H) + x(y + U_0)c_L}{U_0(x - y) + y(3x + y)}.$$

Substituting p_H^* and p_L^* into θ_H and θ_L , it follows that at the optimum, both services are offered (i.e., $\theta_H > \theta_L$) if and only if $c_H > (x-U_0)(2xc_L-(x-y)(y-U_0))/x(x+y)(y-U_0)$. Although this condition holds when $c_L = c_H = 0$ (the case that Bolton and Bonanno consider), it need not hold in general. For instance, if $U_0 =$

Second, using a very similar model to ours, Deneckere and McAfee (1996) show that under certain conditions, a vertically integrated manufacturer will offer both services even if $c_L > c_H$. That is, the manufacturer will offer a "damaged good" (i.e., a costly inferior version of its product) in order to price discriminate. The reason why this possibility does not arise in our model is that in Deneckere and McAfee, the valuation of the damaged good is $\lambda(\theta)$, where $\lambda(\theta) \leq \theta$ and $0 \leq \lambda'(\theta) < 1$. Lemma 3 in their paper shows that a necessary condition for introducing a damaged good is that $\lambda(\theta)/\theta$ is strictly decreasing; since we assume that $\lambda(\theta) = \gamma S\theta$, $\lambda(\theta)/\theta$ is a constant in our paper and hence it is never optimal to introduce a damaged good.¹³

Given the assumption that $c_H < c_L/\gamma$ which ensures that only the high quality is offered, the profit of a vertically integrated manufacturer is given by the second line of equation (4). The first order condition for the manufacturer's problem is given by:

$$\frac{\partial \pi^{VI}}{\partial p_H} = (1 - F(\theta_H)) - \frac{f(\theta_H)}{S} (p_H - c_H) = 0, \quad (5)$$

where $\theta_H = p_H/S$. Substituting $p_H = \theta_H S$ into equation (5), the equation can be rewritten as follows:

$$S M(\theta_H) = c_H, \quad M(\theta_H) \equiv \theta_H - \frac{1 - F(\theta_H)}{f(\theta_H)}. \quad (6)$$

Let θ^* be the solution to equation (6). Following Mussa and Rosen (1978), we can interpret $SM(\theta)$ as the marginal revenue function associated with incremental quality. Viewed in this way, equation (6) is simply the usual monopoly solution stating that at the optimum, marginal revenue equals marginal cost. The function $M(\theta)$ is strictly increasing because by assumption, $(1-F(\theta))/f(\theta)$ is nonincreasing. Assuming that $M(\underline{\theta}) = \underline{\theta} - 1/f(\underline{\theta}) < 0$ (which is the case for instance if $\underline{\theta} = 0$), and noting that the assumption that $c_H < S\bar{\theta}$, implies that $c_H < S\bar{\theta} = SM(\bar{\theta})$, it follows that equation (6) defines a unique θ^* such that $0 < \theta^* < \bar{\theta}$. Given θ^* , the manufacturer charges a price of $p_H^* = \theta^* S$ for the high quality service.

1, $y = 2$, $x = 4$, and $c_L = 1/2$, then the condition fails if $c_H < 3/4$, in which case the manufacturer will offer only the high quality product.

¹³ Another related result is due to Fudenberg and Tirole (1998) who study a similar model to ours but in their model there are two periods. In period 1 the manufacturer produces a basic version of a durable good and in period 2 it offers an improved version of the same good. They show that if the manufacturer can lease the good in period 1 rather than sell it, then in period 2 it will offer both versions, although it will not produce new units of the basic version. The manufacturer offers both versions because the basic units are already available in period 2 at no cost. This is consistent with Proposition 1 above that shows that if $c_H > 0 = c_L$ then it is always optimal to offer both high and low qualities.

4. Vertical restraints when the market cannot be vertically segmented

In this section we consider vertical restraints in markets that cannot be vertically segmented according to the consumers' willingness to pay for quality. In other words, the manufacturer cannot prevent consumers from buying from the "wrong" retailer. The main result here is that if the cost difference between the high and the low quality services is not so big as to reverse the rankings of the two services, the manufacturer will foreclose retailer L and will only deal with retailer H. Moreover, if the manufacturer can use franchise fees then it is possible to replicate the vertically integrated outcome. Otherwise the manufacturer will earn less than in the vertical integration case although retailer L will still be foreclosed.

Given our assumption that $c_H < c_L/\gamma$, Proposition 1 reveals that a vertically integrated manufacturer will only offer the high quality service and will charge $p_H^* = \theta^*S$. The manufacturer's profit then is $\pi_H^* = (1-F(\theta^*))(\theta^*S - c_H)$. If the manufacturer can use two-part tariffs, he can achieve the same profit by making retailer H an exclusive distributor and setting a 0 wholesale price. Since retailer H is an exclusive distributor and the wholesale price is 0, the retailer's profit is given by the second line of equation (4), so at the optimum, retailer H will charge $p_H^* = \theta^*S$ and will earn π_H^* . The manufacturer can then fully extract this profit via a franchise fee.

Another way to replicate the vertically integrated outcome is to set a 0 wholesale price, impose on both services a minimum RPM equal to θ^*S , and charge retailer H a franchise fee equal to π_H^* . Given this minimum RPM, retailer H will set his price at $p_H^* = \theta^*S$; since retailer L cannot price below p_H^* , his market share will be 0. Hence, the resulting outcome is exactly as in the case where retailer H becomes an exclusive distributor.¹⁴ Alternatively, the manufacturer can set the wholesale price equal to $p_H^* - c_H$ and set a maximum RPM on both services equal to p_H^* . Once again, only retailer H will be able to operate in the market and the maximum RPM will be binding. Since under this scheme retailer H breaks even, the entire industry profits will accrue to the manufacturer.

The manufacturer however does not need to rely on an exclusive distribution arrangement or impose an RPM: a two-part tariff with $w = 0$ and a franchise fee of π_H^* offered to both retailers will also replicate the vertically integrated outcome. To see why, note that since $w = 0$, retailer L's profit is

¹⁴ In fact it is sufficient to impose a minimum RPM equal to θ^*S only on retailer L. In the resulting equilibrium, retailer H will set $p_H^* = \theta^*S$ and retailer L will then be unable to get a positive market share.

$$\pi_L^* = \underset{p_L}{\text{Max}} (F(\theta_H) - F(\theta_L))(p_L - c_L), \quad (7)$$

where θ_H and θ_L are given by equation (3). Using equation (3), retailer L's profit could be also written as:

$$\pi_L^* = \underset{\theta}{\text{Max}} (F(\theta_H) - F(\theta))(\gamma S\theta - c_L). \quad (8)$$

Since $c_H < c_L/\gamma$, and using a revealed preferences argument, it follows that

$$\begin{aligned} \pi_L^* &< \underset{\theta}{\text{Max}} (1 - F(\theta))(\gamma S\theta - c_L) \\ &< \underset{\theta}{\text{Max}} (1 - F(\theta))(\gamma S\theta - \gamma c_H) \\ &< \underset{\theta}{\text{Max}} (1 - F(\theta))(S\theta - c_H) \equiv \pi_H^*. \end{aligned} \quad (9)$$

Therefore if both retailers are required to pay a franchise fee of π_H^* , only retailer H will be able to pay it and operate in the market (retailer L cannot pay π_H^* even if he operates alone in the market). Given that the wholesale price is 0, the resulting outcome coincides with the vertically integrated outcome.

We now summarize the discussion in the following proposition:

Proposition 2: *Assume that $c_H < c_L/\gamma$ (a vertically integrated manufacturer will only offer the high quality service). Then, the manufacturer can replicate the vertically integrated outcome by either (i) making retailer H an exclusive distributor and charging a 0 wholesale price and a franchise fee equal to π_H^* , (ii) imposing a minimum RPM equal to $p_H^* = \theta^*S$, and charging a 0 wholesale price and a franchise fee equal to π_H^* , (iii) imposing a maximum RPM equal to p_H^* and charging a wholesale price equal to $p_H^* - c_H$, or (iv) setting a 0 wholesale price and a uniform franchise fee equal to π_H^* .*

Proposition 2 suggests that by refusing to deal with low quality retailers, manufacturers can boost their overall profits by preventing consumers from switching to less profitable low quality services. This may shed light on why manufacturers often refuse to deal with low quality, discount retailers (see the examples mentioned in the Introduction). The last part of Proposition 2 implies that so long as a vertically integrated manufacturer finds it optimal to offer only the high quality service, then exclusive distribution (ED) agreements with high quality retailers and RPM are neutral as far as welfare is concerned since the

manufacturer can foreclose low quality retailers even without using these arrangements. This suggests in turn that ED and RPM are not used, in the context of our model, with the sole purpose of foreclosing low quality retailers and hence should be condemned on that basis alone.

Proposition 2 is somewhat surprising since Bolton and Bonanno (1988, Proposition 3) show in a closely related model that franchise fees and RPM are insufficient to implement the vertically integrated outcome. The reason for this difference is that in the Bolton and Bonanno model where $c_L = c_H = 0$ and the range of consumers types is "wide," a vertically integrated manufacturer always prefers to offer both services. Franchise fees fail to implement the vertically integrated outcome because they induce an excessive price competition between the two retailers which dissipates some of the profits that the manufacturer can capture via the franchise fees. In our model, it is optimal to offer only the high quality service, so franchise fees lead to a foreclosure of retail L and hence prevent dissipative price competition. As for RPM, then in the Bolton and Bonanno model, both retailers can select the quality of their services. RPM fails to replicate the vertically integrated outcome because it eliminates the retailers' incentives to differentiate their qualities. In our model where qualities are predetermined, there is no such adverse incentive effect.

Next, we examine the robustness of the foreclosure result with respect to the assumption that the manufacturer can fully extract the retailers' profits through franchise fees. In practice, franchise fees might be substantially smaller than the retailers' (expected) profits, say due to demand or cost uncertainties and retailers risk-aversion (see e.g., Rey and Tirole, 1986). One might suspect that if the manufacturer cannot extract the entire retailers' profits via franchise fees and cannot impose vertical restraints, then he may wish to deal with both retailers even if $c_H < c_L/\gamma$ (in which case a vertically integrated manufacturer will offer only the high quality service) in order to expand the size of the market and boost his revenues from wholesale. We therefore consider now the opposite extreme case where the manufacturer cannot use franchise fees at all and needs to rely only on a uniform wholesale price. Given a uniform wholesale price, w , the retailers' profits are:

$$\pi_H(w) = (1 - F(\theta_H))(p_H - c_H - w), \quad (10)$$

and

$$\pi_L(w) = \begin{cases} (F(\theta_H) - F(\theta_L))(p_L - c_L - w), & p_H > p_L/\gamma, \\ 0, & p_H \leq p_L/\gamma. \end{cases} \quad (11)$$

Given w , the two retailers simultaneously choose p_H and p_L to maximize their respective profits. Let the Nash equilibrium choices be $p_H(w)$ and $p_L(w)$. The manufacturer then sets the wholesale price, w , to maximize his revenue from wholesale:

$$\pi(w) = (Q_H(w) + Q_L(w))w, \quad (12)$$

where $Q_H(w)$ and $Q_L(w)$ are given by equation (2), evaluated at $p_H(w)$ and $p_L(w)$. To facilitate the analysis, we shall only consider the case where the distribution of consumers' types is uniform on the interval $[0, \bar{\theta}]$.

Proposition 3: *Suppose that the distribution of consumers' types is uniform on the interval $[0, \bar{\theta}]$. Then, if the manufacturer can only charge a uniform wholesale price per unit (but not franchise fees), the equilibrium wholesale price will be set at a point at which retailer L will be effectively foreclosed. In equilibrium, the manufacturer's sales are less than in the vertical integration case.*

Absent franchise fees, the manufacturer faces a trade-off between lowering the wholesale price and expanding the size of the market and setting a high wholesale price and earning more money on each unit. Proposition 3 shows that the optimal solution to this trade-off occurs at a point where retailer L cannot profitably operate in the market. This implies that the incentive to foreclose the low quality retailer result persists even if the manufacturer cannot use franchise fees.

Since in equilibrium, $w^{**} > 0$, there is a double marginalization problem: the retail price is too high from the manufacturer's point of view so the manufacturer's sales are less than in the vertical integration case. As is standard in the literature, the manufacturer can eliminate the double marginalization and replicate the vertically integrated outcome by imposing a maximum RPM equal to θ^*S , and charges a wholesale price equal to $\theta^*S - c_H$. Then, retailer H will set a retail price $p_H^* = \theta^*S$ and will serve consumers with $\theta \geq \theta^*$. Consequently, the manufacturer's profit is $(1-F(\theta^*))(\theta^*S - c_H)$, exactly as in the vertical integration case. Not surprisingly, the use of a maximum RPM in this case is welfare enhancing as it expands the size of the market and allows more customers to buy the manufacturer's product.

Thus far we only considered the case where $c_H < c_L/\gamma$. We conclude this section by examining

the case where $c_L/\gamma < c_H < c_L + (1-\gamma)S\bar{\theta}$. In this case, a vertically integrated manufacturer prefers to offer both services. The resulting retail prices are $p_H^{**} = (\gamma\theta_L^{**} + (1-\gamma)\theta_H^{**})S$ and $p_L^{**} = \theta_L^{**}\gamma S$, where θ_H^{**} and θ_L^{**} are defined implicitly by equation (A-3) in the Appendix. Clearly, an exclusive distribution agreement with retailer H will no longer be optimal. Likewise, a uniform two part tariff can no longer replicate the vertically integrated outcome because price competition between the two retailers will dissipate the manufacturer's profits. One way to prevent this price competition, is to impose a minimum RPM equal to p_H^{**} on retailer H and a minimum RPM equal to p_L^{**} on retailer L. Together with a 0 wholesale price and franchise fees that are equal to the retailers' profits, π_H^{**} and π_L^{**} , the manufacturer can replicate the vertically integrated outcome.

The previous solution calls for imposing one RPM on the high quality service and another one on the low quality service. However, the manufacturer can also replicate the vertically integrated outcome with a single RPM. The first way to do that is to set a wholesale price, w^{**} , that induces retailer L to set a price $p_L = p_L^{**}$. In the Appendix, we show that this wholesale price induces retailer H to set a price p_H that falls below p_H^{**} . Hence, the manufacturer needs to set a minimum RPM of p_H^{**} on the high quality service. Together with franchise fees that fully extract the retailers' profits, this scheme can also replicate the vertically integrated outcome. Alternatively, the manufacturer can set a wholesale price equal to $w^{**} = \theta_L^{**}\gamma S - c_L$. This wholesale price induces retailer H to set the vertically integrated retail price p_H^{**} . In the Appendix we show that this wholesale price induces retailer L to set a retail price above p_L^{**} so the manufacturer needs to impose a maximum RPM on the low quality service. Finally, since at w^{**} , the per-unit profit of retailer L is 0, the manufacturer only needs to extract retailer H's profits via a franchise fee.

Proposition 4: *Assume that $c_L/\gamma < c_H < c_L + (1-\gamma)S\bar{\theta}$ (a vertically integrated manufacturer will offer both services). Now the vertically integrated outcome cannot be implemented by ED or a uniform franchise fee. Nonetheless, the manufacturer can still replicate the vertically integrated outcome by either (i) setting a 0 wholesale price, imposing minimum RPM on the high and low quality services that specify the minimum retail prices p_H^{**} and p_L^{**} , and setting franchise fees equal to π_H^{**} and π_L^{**} , (ii) setting a wholesale price that induces retailer L to charge $p_L = p_L^{**}$, imposing a minimum RPM of p_H^{**} on the high quality service, and setting franchise fees that fully extract the retailers' profits, or (iii) setting a wholesale price $w^{**} = \theta_L^{**}\gamma S - c_L$, imposing a maximum RPM of p_L^{**} on the low quality service, and setting a franchise fee on retailer H that fully extracts retailer H's profit.*

5. Customer restrictions

This section considers markets in which consumers can be vertically segmented according to their willingness to pay for quality. In this kind of markets, the manufacturer may choose to impose Customer Restrictions (CR) by requiring retailer H to deal only with high type consumers and requiring retailer L to deal only with low type consumers. For instance, if large corporations have on average a higher willingness to pay than individuals, the manufacturer will require retailer H to deal exclusively with corporate customers and retailer L to deal exclusively with individual customers. Likewise, if consumers who buy at upscale shops care more about quality of service than those who buy through mail orders, the manufacturer can impose CR by requiring retailer L to sell only through mail orders and requiring retailer H to sell only in upscale shops. The advantage of CR from the manufacturer's point of view is that it facilitates price discrimination without inducing high type customers to switch to the low quality retailer. Customers restrictions intended to facilitate price discrimination have been present in mechanics' tools and truck markets, in passenger automobiles, drugs, and lightbulbs (Caves, 1984), in cosmetics and hair products and in newspapers distribution (see footnote 7). Our main finding in this section is that if the manufacturer can use franchise fees, he will always choose to impose CR and will have a dual distribution system whereby both retailers will be active. Relative to the case where retailer L is foreclosed, CR benefit not only the manufacturer, but also low type consumers and possibly "intermediate" type consumers, although they harm high type consumers. We also show that without franchise fees the manufacturer may prefer to forgo CR and deal exclusively with retailer H, especially if the low quality service is a poor substitutes for the high quality service.

Under CR the manufacturer chooses a critical value of θ , denoted by θ_{CR} and assigns customers with $\theta \geq \theta_{CR}$ to retailer H and customers with $\theta < \theta_{CR}$ to retailer L. The two retailers then become monopolists in their respective segments of the market and choose retail prices to maximize their profits.¹⁵ Assuming that the manufacturer can fully extract the retailers' profits via franchise fees, it is optimal to set a 0 wholesale price to avoid double marginalization. As it turns out, it is more convenient to express the retailers' profits in terms of θ_H and θ_L instead of p_H and p_L . To this end, note that if $\theta_H > \theta_{CR}$, the choice of θ_{CR} is not binding on retailer H; since the utility of consumers who buy from retailer H is $\theta S - p_H$, the price that retailer H can charge is $p_H = \theta_H S$. Otherwise, if $\theta_H = \theta_{CR}$, then $p_H = \theta_{CR} S$.

¹⁵ We assume though that both retailers must set uniform prices for their services and cannot price discriminate. Clearly, if price discrimination was possible, the manufacturer would have preferred to deal exclusively with retailer H and allow him to engage in price discrimination.

Likewise, if $0 \leq \theta_L < \theta_{CR}$, the utility of consumers who buy from retailer L is $\theta_L \gamma S - p_L$, so $p_L = \theta_L \gamma S$. If $\theta_L = \theta_{CR}$, there is no demand for the low quality service. Hence, the profits of the two retailers, gross of the franchise fees, are

$$\pi_H^{CR}(\theta_H) = \begin{cases} (1 - F(\theta_{CR}))(\theta_{CR} S - c_H), & \theta_H = \theta_{CR} \\ (1 - F(\theta_H))(\theta_H S - c_H), & \theta_{CR} < \theta_H \leq \bar{\theta}, \end{cases} \quad (13)$$

and

$$\pi_L^{CR}(\theta_L) = \begin{cases} (F(\theta_{CR}) - F(\theta_L))(\theta_L \gamma S - c_L), & 0 \leq \theta_L < \theta_{CR} \\ 0, & \theta_L = \theta_{CR} \end{cases} \quad (14)$$

Let θ_H^{CR} and θ_L^{CR} , respectively, be the maximizers of $\pi_H(\theta_H)$ and $\pi_L(\theta_L)$, given θ_{CR} . Equation (13) implies that $\theta_H^{CR} = \text{Max}\{\theta_{CR}, \theta^*\}$, where θ^* is defined implicitly by equation (6). Since θ^* is unique, so is θ_H^{CR} . Equation (14) implies that $\theta_L^{CR} = \text{Min}\{\theta_{CR}, \theta_L^*\}$, where θ_L^* is defined implicitly by the equation $\gamma S(\theta - (F(\theta_{CR}) - F(\theta))/f(\theta)) = c_L$. The assumption that $1 - F(\theta)/f(\theta)$ is nonincreasing implies that the right side of the equation is strictly increasing so θ_L^{CR} is unique as well.¹⁶ Since the manufacturer can fully extract the retailers' profits through the franchise fees, θ_{CR} is set to maximize the expression

$$\pi(\theta_{CR}) = \pi_H(\theta_H^{CR}) + \pi_L(\theta_L^{CR}). \quad (15)$$

We denote the maximizer of $\pi(\theta_{CR})$ by θ_{CR}^* .

To characterize the equilibrium, note that setting θ_{CR} below θ^* is dominated from the

¹⁶ To see why, note that

$$\frac{d}{d\theta} \left[\theta - \frac{F(\theta_{CR}) - F(\theta)}{f(\theta)} \right] = \frac{2f^2(\theta) + f'(\theta)(F(\theta_{CR}) - F(\theta))}{f^2(\theta)}.$$

If $f'(\theta) \geq 0$, the derivative is positive as required. If $f'(\theta) < 0$, then since by assumption, $1 - F(\theta)/f(\theta)$ is nonincreasing, $M(\theta) \equiv \theta - 1 - F(\theta)/f(\theta)$ is strictly increasing, so as a result,

$$\begin{aligned} \frac{d}{d\theta} \left[\theta - \frac{F(\theta_{CR}) - F(\theta)}{f(\theta)} \right] &= \frac{2f^2(\theta) + f'(\theta)(F(\theta_{CR}) - F(\theta))}{f^2(\theta)} \\ &> \frac{2f^2(\theta) + f'(\theta)(1 - F(\theta))}{f^2(\theta)} = M'(\theta) > 0. \end{aligned}$$

manufacturer's perspective by the strategy $\theta_{CR} = \theta^*$, because it implies that consumers in the interval $[\theta_{CR}, \theta^*]$ are not served, despite the fact that they are the most profitable consumers for retailer L. Hence, we can restrict attention to $\theta_{CR} \geq \theta^*$. This implies in turn that the choice of θ_{CR} will be binding on retailer H; that is, $\theta_H^{CR} = \theta_{CR}$.

Before considering θ_L^{CR} , note that if $c_L/\gamma S > \theta^*$, retailer L's entry into the downstream market is blockaded. To see why, recall that if retailer H is a monopolist, then the lowest type served by retailer H is $\theta_H = \theta^*$. The utility of this type from buying from retailer H is equal to 0 because $p_H^* = \theta^*S$. If type θ^* buys from retailer L, then his utility is $\theta^*\gamma S - p_L$. But if $c_L/\gamma S > \theta^*$, then $\theta^*\gamma S - p_L < (c_L/\gamma S)\gamma S - p_L = c_L - p_L \leq 0$, implying that type θ^* is better-off buying from retailer H. As Figure 1 shows, if type θ' prefers to buy from retailer H, so will all types $\theta > \theta'$. Hence, retailer L cannot successfully compete against retailer H even if the latter sets a monopoly price. In what follows we shall therefore restrict attention to cases where retailer L is an effective competitor by assuming that $c_L/\gamma S < \theta^*$.

Given our assumption that $c_L/\gamma S < \theta^*$ and since we already established that $\theta_{CR} \geq \theta^*$, it is easy to see from equation (14) that there exists a $\theta_L^{CR} \in [c_L/\gamma S, \theta_{CR}]$ such that $\pi_L^{CR}(\theta_L^{CR}) > 0$. Hence, under CR, retailer L will operate in the market and will serve all consumers in the interval $[\theta_L^{CR}, \theta_{CR}]$:

Proposition 5: *Suppose that $c_L/\gamma S < \theta^*$ (entry by retailer L is not blockaded). Then under CR, the manufacturer will set $w = 0$ and will segment the market vertically by requiring retailer H to deal with customers with $\theta \geq \theta_{CR}^*$ and retailer L to deal with customers with $\theta < \theta_{CR}^*$. In the resulting equilibrium, retailer H serves consumers with $\theta \in [\theta_{CR}^*, \bar{\theta}]$ and charges $p_H^{CR} = \theta_{CR}^*S$, whereas retailer L serves consumers with $\theta \in [\theta_L^{CR}, \theta_{CR}^*)$ and charges $p_L^{CR} = \theta_L^{CR}\gamma S$.*

Proposition 5 shows that under CR the manufacturer will have a dual distribution system and will deal with both retailers. It is worth noting that in order to implement the CR outcome, the manufacturer does not need to impose a customer restriction on both retailers: the restriction on retailer H can be replaced with a minimum RPM of θ_{CR}^*S on the high quality service. This minimum RPM will be binding since absent any restriction, retailer H would rather lower p_H from θ_{CR}^*S to θ^*S (Proposition 7 below establishes that $\theta^* \leq \theta_{CR}^*$) and serve some of the customers that were assigned to retailer L. As for retailer L, then since $p_L^{CR} = \theta_L^{CR}\gamma S$, the utility of a consumer who buys from retailer L is $U_L(\theta) = \theta\gamma S - \theta_L^{CR}\gamma S$. If the consumer buys from retailer H, his utility is $U_H(\theta) = \theta S - \theta_{CR}^*S$. Since $U_H(\theta) - U_L(\theta)$ is increasing with θ and since $U_H(\theta_{CR}) = 0 < U_L(\theta_{CR})$, it is clear that consumers with $\theta \leq \theta_{CR}$ will never wish to buy from retailer H, while some consumers with $\theta > \theta_{CR}$ would be better-off switching to retailer L.

Hence, given the minimum RPM on retailer H, the manufacturer only needs to worry about retailer L serving some of retailer's H customers but never vice versa.

In practice, the manufacturer cannot directly observe the willingness of consumers to pay for quality and needs to infer it from some observed characteristics of the buyers (e.g., geographic location, businesses vs. individuals, large vs. small business, etc). If these characteristics are not perfectly correlated with θ_{CR}^* , the manufacturer may end up implementing a θ_{CR} which is either above or below θ_{CR}^* . However, if the manufacturer errs by setting θ_{CR} below θ_{CR}^* , his profit cannot be lower than it is absent CR since in the worst case scenario, θ_{CR} will be so low that retailer L will be foreclosed, in which case the manufacturer's profit is as in Section 4. Hence, from the manufacturer's point of view, the real "danger" is to set θ_{CR} above θ_{CR}^* , in which case the sales of retailer H are too low so that the manufacturer can actually be better-off not relying on CR altogether.

It is worth emphasizing that the result that CR gives rise to a dual distribution system does depend on the assumption that the manufacturer can charge franchise fees. In the next proposition we show that absent franchise fees, the manufacturer may raise the wholesale price to the point where retailer L is effectively foreclosed, at least in the case where the low quality service is a poor substitutes for the high quality service. To facilitate the analysis we only consider cases where the distribution of consumers' types is uniform on the interval $[0, \bar{\theta}]$.

Proposition 6: *Suppose that the distribution of consumers' types is uniform on the interval $[0, \bar{\theta}]$ and assume that the manufacturer cannot use franchise fees. Then if $\gamma < 2/5$ (the low quality service is a poor substitutes for the high quality service) the manufacturer will raise the wholesale price to the point where retailer L will be effectively foreclosed.*

As noted above, in the absence of franchise fees, the choice of a wholesale price involves a tradeoff between raising the wholesale price to earn more money on each unit sold, and lowering the wholesale price to boost sales. Intuitively, when γ is small, the gain in sales from lowering the wholesale price is small so the manufacturer raises the wholesale price up to the point where retailer L cannot successfully compete with retailer H.

We now return to the case where the manufacturer can use franchise fees and wish to compare the outcome under CR with the outcomes under two-part tariffs, ED, and RPM, characterized in Proposition 2. We begin by characterizing θ_{CR}^* . Given that $\theta_H^{CR} = \theta_{CR}$ and using the envelop theorem, the first order condition for θ_{CR}^* is:

$$\frac{d\pi(\theta_{CR})}{d\theta_{CR}} = S(1 - F(\theta_{CR})) - f(\theta_{CR})(\theta_{CR}S - \theta_L^{CR}\gamma S - (c_H - c_L)) = 0, \quad (16)$$

Using the definition of $M(\theta)$, this condition can also be written as follows:

$$SM(\theta_{CR}) = c_H + \theta_L^{CR}\gamma S - c_L. \quad (17)$$

Since $M(\theta)$ is strictly increasing, θ_{CR}^* is defined uniquely. Noting that $\theta_L^{CR}\gamma S - c_L$ is the equilibrium price-cost margin of retailer L (and hence is nonnegative), it follows that the right side of equation (17) is at least as large as the right side of equation (6). Hence, $\theta^* \leq \theta_{CR}^*$, so retailer H serves fewer consumers under CR than under two-part tariffs, ED, or an RPM. Moreover, $\theta_{CR}^* < \bar{\theta}$, otherwise retailer H is foreclosed; this however cannot arise in equilibrium as the manufacturer would rather foreclose retailer L, say by setting $\theta_{CR}^* = 0$, and deal exclusively with retailer H.

Although retailer H serves fewer consumers than under optimal two-part tariffs, ED, and RPM, the total size of the market may nonetheless increase under CR because retailer L is also active in the market. We establish this result by comparing θ_L^{CR} which is the lowest type that still buys under CR and θ^* which is the lowest type served absent CR:

Proposition 7: *Suppose that $c_L/\gamma S < \theta^*$ (entry by retailer L is not blockaded). Then $\theta_L^{CR} < \theta^* \leq \theta_{CR}^*$.*

Next we show that the manufacturer will always prefer CR over two-part tariffs, ED, and RPM. To this end, let $\pi^{CR} \equiv \pi^{CR}(\theta_{CR}^*)$ be the equilibrium profit of the manufacturer under CR. By revealed preferences it follows that

$$\begin{aligned} \pi^{CR} &= (1 - F(\theta_{CR}^*)) (\theta_{CR}^* S - c_H) + \text{Max} \left\{ (F(\theta_{CR}^*) - F(\theta_L^{CR})) (\theta_L^{CR} \gamma S - c_L), 0 \right\} \\ &> (1 - F(\theta^*)) (\theta^* S - c_H) + \text{Max} \left\{ (F(\theta^*) - F(\theta_L^{CR})) (\theta_L^{CR} \gamma S - c_L) \right\}. \end{aligned} \quad (18)$$

Recalling that $p_H^* = \theta^* S$, the first term on the second line of the equation is the manufacturer's profit under optimal two-part tariffs, ED, and RPM. Hence, the manufacturer is better-off under the CR than under optimal two-part tariffs, ED, and RPM. Intuitively, under CR, the high end of the market is shielded against competition from retailer L who is not allowed to sell to consumers with $\theta \geq \theta_{CR}^*$. Hence it is now possible to raise prices at the high end of the market without having to foreclose retailer L and losing the business of lower type consumers.

The impact of CR on consumers is more complex since we need to distinguish between at least three groups of consumers. First, at the top end of the market, consumers with $\theta \in [\theta_{CR}^*, \bar{\theta}]$, are served by retailer H under both CR, optimal two-part tariffs, ED, and RPM. But since $p_H^{CR} > p_H^*$, this group of consumers is made worse-off under CR.

Second, low type consumers with $\theta \in [\theta_L^{CR}, \theta^*]$ are not served at all under two-part tariffs, ED, and RPM, but are served under CR by retailer L. Hence, CR benefits consumers in the second group.

Third, consumers with $\theta \in [\theta^*, \theta_{CR}^*]$ are served by retailer H under optimal two-part tariffs, ED, and RPM, pay $p_H^* = \theta^*S$, and obtain a utility of $U^*(\theta) = \theta S - \theta^*S$. Under CR in contrast, these consumers are served by retailer L, pay $p_L^{CR} = \theta_L^{CR}\gamma S$, and obtain a utility of $U^{CR}(\theta) = \theta\gamma S - \theta_L^{CR}\gamma S$. Since $U^*(\theta^*) = 0$, CR surely benefits consumers with θ close to θ^* . However, since $U^{CR}(\theta) - U^*(\theta)$ is decreasing with θ , consumers with θ close to θ_{CR} might be hurt by CR. To examine this issue, note that at the top end of the second group, $U^{CR}(\theta_{CR}^*) - U^*(\theta_{CR}^*) = (\theta^* - \gamma\theta_L^{CR} - (1-\gamma)\theta_{CR}^*)S$. If $\theta^* > \gamma\theta_L^{CR} + (1-\gamma)\theta_{CR}^*$, then $U^{CR}(\theta_{CR}^*) > U^*(\theta_{CR}^*) > 0$ implying that CR benefits all consumers in the second group; otherwise there is some cutoff level, $\hat{\theta} \in [\theta^*, \theta_{CR}^*]$, such that CR benefits consumers with $\theta \in [\theta^*, \hat{\theta}]$ and hurts consumers with $\theta \in [\hat{\theta}, \theta_{CR}^*]$. We summarize this discussion as follows:

Proposition 8: *The manufacturer always prefers CR over two-part tariffs, ED or RPM. As for consumers, relative to optimal two-part tariffs, ED, and RPM,*

- (i) *consumers with $\theta \in [\theta^{CR*}, \bar{\theta}]$ are hurt by CR,*
- (ii) *consumers with $\theta \in [\theta_L^{CR}, \theta^*]$ benefit from CR, and*
- (iii) *consumers with $\theta \in [\theta^*, \theta_{CR}^*]$ benefit from CR if $\theta^* > \gamma\theta_L^{CR} + (1-\gamma)\theta_{CR}^*$; otherwise, there exists some cutoff level, $\hat{\theta} \in [\theta^*, \theta_{CR}^*]$, such that CR benefits consumers with $\theta \in [\theta^*, \hat{\theta}]$ and hurts consumers with $\theta \in [\hat{\theta}, \theta_{CR}^*]$.*

Next we wish to examine the welfare implications of CR. As usual, we define social welfare as the sum of consumer surplus and profits. Absent CR, the manufacturer deals exclusively with retailer H. Since retailer H serves customers with θ above θ^* , social welfare is given by:

$$W^* = CS^* + \pi^* = \int_{\theta^*}^{\bar{\theta}} [\theta S - c_H] dF(\theta). \quad (19)$$

Under CR, the manufacturer deals with both retailers and social welfare is given by

$$W^{CR} = CS^{CR} + \pi^{CR} = \int_{\theta_L^{CR}}^{\theta_{CR}^*} [\theta \gamma S - c_L] dF(\theta) + \int_{\theta_{CR}^*}^{\bar{\theta}} [\theta S - c_H] dF(\theta). \quad (20)$$

To facilitate the comparison of W^* and W^{CR} , we restrict attention to the case where the distribution of consumer types is uniform on the interval $[0, \bar{\theta}]$ and establish the following result:

Proposition 9: *Suppose that $c_L/\gamma S < \theta^*$ (entry by retailer L is not blockaded) and suppose that the distribution of consumers' types is uniform on the interval $[0, \bar{\theta}]$. Then CR is welfare enhancing if $c_L < \hat{c}_L$ and welfare reducing if $c_L > \hat{c}_L$, where*

$$\hat{c}_L \equiv \frac{\gamma \left((20 - 3\gamma)c_H + (4 + \gamma)\bar{\theta}S \right)}{2(12 - \gamma)}. \quad (21)$$

Proposition 9 implies that CR is socially desirable provided that c_L is sufficiently lower than c_H . To illustrate, if $c_H = 4$, $\gamma = 1/2$, $S = 10$, and $\bar{\theta} = 1$, then $\hat{c}_L = 2.587$ so CR is welfare enhancing if $2 \leq c_L < 2.587$ (note that $c_L \geq \gamma c_H = 2$) and welfare reducing if $2.587 < c_L < 3.5$ (to ensure that L's entry is not blockaded, we assume that $c_L \leq \theta^* \gamma S$, which in the case where θ is distributed uniformly on the interval $[0, \bar{\theta}]$, is equal to $\gamma(\bar{\theta}S + c_H)/2 = 3.5$).

6. Conclusion

We considered an intrabrand competition model with two vertically differentiated retailers and established two main results. First, in anonymous markets that cannot be vertically segmented according to the willingness of consumers to pay for quality, the manufacturer may wish to foreclose the low quality retailer in order to shield the high quality retailer from a competitive pressure that dissipates the profits from retail. This provides a new explanation for why manufacturers of such diverse products like jeans, shoes, fine fragrances, copiers services, tires, and eyewear, often refuse to deal with low quality discount retailers. To foreclose the low quality retailer, the manufacturer can either use vertical restraints like an exclusive distribution agreement with the high quality retailer, or an RPM, or set a sufficiently high franchise fee. The fact that foreclosure can be achieved even without vertical restraints suggests that exclusive distribution agreements or RPM are not used primarily to foreclose low quality retailers and hence should be condemned on that basis.

We then showed that in markets that can be vertically segmented according to the willingness of consumers to pay for quality, the manufacturer will impose customer restrictions by requiring the low quality retailer to serve consumers whose willingness to pay for quality is below some threshold while requiring the high quality retailer to serve consumers whose willingness to pay for quality is above the threshold. The advantage of this restriction is that it shields the high quality retailer from competition from the low quality retailer, while still enabling the manufacturer to reach the low end of the market through the low quality retailer. Consequently, customer restrictions allow more consumers to be served and may therefore enhance welfare especially if the cost of the low quality retailer is low.

Appendix

Following are the proofs of Proposition 1, 3, 4, 6, 7, and 9.

Proof of Proposition 1: Suppose that both services are offered in equilibrium, so that $\theta_L < \theta_H < \bar{\theta}$. Using equation (3), we can express the prices of the two services as $p_L = \theta_L \gamma S$ and $p_H = \theta_L \gamma S + \theta_H (1 - \gamma) S$. Substituting these equalities into equation (4), we can express the manufacturer's profit in terms of θ_L and θ_H . The manufacturer's problem then is to find θ_L and θ_H to maximize his profit. The first order conditions for the manufacturer's problem are given by

$$\frac{\partial \pi^{VI}}{\partial \theta_H} = (1 - \gamma) S (1 - F(\theta_H)) - f(\theta_H) (\theta_H (1 - \gamma) S - c_H + c_L) = 0, \quad (\text{A-1})$$

and

$$\frac{\partial \pi^{VI}}{\partial \theta_L} = \gamma S (1 - F(\theta_L)) - f(\theta_L) (\theta_L \gamma S - c_L) = 0. \quad (\text{A-2})$$

These first order conditions can be also written as:

$$S M(\theta_H) = \frac{c_H - c_L}{1 - \gamma}, \quad S M(\theta_L) = \frac{c_L}{\gamma}, \quad (\text{A-3})$$

where $M(\theta) \equiv \theta - (1 - F(\theta))/f(\theta)$. Noting that the assumption that $(1 - F(\theta))/f(\theta)$ is nondecreasing implies that $M(\theta)$ is strictly increasing, it follows that the two equations (A-3) in give rise to a unique solution. Moreover, since $c_H < c_L/\gamma$, it follows that $\theta_L > \theta_H$, thereby contradicting the hypothesis that both services are offered. On the other hand, if $c_H > c_L/\gamma$, then equation (A-3) implies that $\theta_L < \theta_H$. To find a condition that ensures that $\theta_H < \bar{\theta}$, note that $M(\bar{\theta}) = \bar{\theta}$. Together with the fact that $M(\theta)$ is strictly increasing, it follows from equation (A-3) that $\theta_H < \bar{\theta}$ so long as $c_H < c_L + (1 - \gamma)\bar{\theta}S$. Otherwise, $\theta_H = \bar{\theta}$ and retailer H is foreclosed. ■

Proof of Proposition 4: Assuming that both retailers operate in the market, i.e., $p_H(w) > p_L(w)/\gamma$, $p_H(w)$ and $p_L(w)$ are defined by the following best-response functions:

$$\frac{\partial \pi_H(w)}{\partial p_H} = (1 - F(\theta_H)) - \frac{f(\theta_H)}{(1-\gamma)S} (p_H - c_H - w) = 0, \quad (\text{A-4})$$

and

$$\frac{\partial \pi_L(w)}{\partial p_L} = (F(\theta_H) - F(\theta_L)) - \left[\frac{f(\theta_H)}{(1-\gamma)S} + \frac{f(\theta_L)}{\gamma S} \right] (p_L - c_L - w) = 0. \quad (\text{A-5})$$

To facilitate the analysis, we will characterize the Nash equilibrium in terms of the values of θ_H and θ_L that are induced by p_H and p_L rather than directly by p_H and p_L . Equation (3) indicates that whenever $p_H > p_L/\gamma$, then $p_H = (\gamma\theta_L + (1-\gamma)\theta_H)S$ and $p_L = \theta_L\gamma S$. Substituting these expressions in equations (A-4) and (A-5) and rearranging, yields:

$$1 - F(\theta_H) - f(\theta_H) \left(\theta_H + \frac{\gamma\theta_L}{1-\gamma} - \frac{c_H + w}{(1-\gamma)S} \right) = 0, \quad (\text{A-6})$$

and

$$F(\theta_H) - F(\theta_L) - \left[\frac{\gamma f(\theta_H)}{1-\gamma} + f(\theta_L) \right] \left(\theta_L - \frac{c_L + w}{\gamma S} \right) = 0. \quad (\text{A-7})$$

Equations (A-6) and (A-7), respectively, define the best-response functions of retailers H and L, BR_H and BR_L , in terms of θ_H and θ_L .

Since we assume that both retailers are active, BR_H and BR_L must intersect in the (θ_H, θ_L) space below the diagonal to ensure that $\theta_H > \theta_L$ (otherwise all consumers will buy from retailer H). From equation (A-6) it is easy to see that BR_H is downward sloping in the (θ_H, θ_L) space and from equation (A-7) it is easy to see that BR_L is upward sloping and crosses the diagonal at $\theta_L = (c_L + w)/\gamma S$ (when $\theta_L = (c_L + w)/\gamma S$, equation (A-7) implies that $\theta_H = \theta_L$). Returning to BR_H , if we substitute $\theta_L = (c_L + w)/\gamma S$ in equation (A-6) and rearrange terms, then the equation can be written as $SM(\theta_H) = (c_H - c_L)/(1-\gamma)$. Let θ^{**} be the solution of this equation. Since $M'(\theta) > 0$, θ^{**} is defined uniquely. Moreover, since $\gamma c_H < c_L$, the right side of the equation is smaller than the right side of equation (6), so $\theta^{**} < \theta^*$. Assuming in addition that $M(\theta) = \underline{\theta} - 1/f(\theta) < 0$, it follows that $\theta^{**} > \underline{\theta}$. We therefore established that BR_H passes through the point $(\theta^{**}, (c_L + w)/\gamma S)$. Therefore, if $w \leq \theta^{**}\gamma S - c_L$, BR_H and BR_L intersect below the diagonal, implying that $\theta_H(w) > \theta_L(w)$ so that by equation (2) both Q_H and Q_L are positive. On the other hand, if $w > \theta^{**}\gamma S -$

c_L , then BR_H and BR_L intersect above the diagonal in which case $\theta_H(w) < \theta_L(w)$, so retailer L is effectively foreclosed.

To prove that the manufacturer will set $w > \theta^{**}\gamma S - c_L$, note that when $F(\theta)$ is uniform on the interval $[0, \bar{\theta}]$, the equation $SM(\theta_H) = (c_H - c_L)/(1 - \gamma)$ implies that

$$\gamma S \theta^{**} - c_L = \frac{\gamma c_H - (2 - \gamma)c_L + \gamma(1 - \gamma)S\bar{\theta}}{2(1 - \gamma)}. \quad (\text{A-8})$$

Now, suppose that $w \leq \theta^{**}\gamma S - c_L$, so that both retailers are active in the market. Given the uniform distribution of $F(\theta)$, equations (A-6) and (A-7) imply that in equilibrium,

$$\theta_H(w) = \frac{(2 - \gamma)c_H - c_L + (1 - \gamma)(2 - \gamma)S\bar{\theta} + (1 - \gamma)w}{(1 - \gamma)(4 - \gamma)S}, \quad (\text{A-9})$$

$$\theta_L(w) = \frac{\gamma c_H + 2c_L + \gamma(1 - \gamma)S\bar{\theta} + (2 + \gamma)w}{\gamma(4 - \gamma)S}.$$

Substituting from equation (A-9) into equation (12) and rearranging terms, the manufacturer's profit is

$$\pi(w) = \frac{(3\gamma S\bar{\theta} - \gamma c_H - 2c_L - (2 + \gamma)w)w}{\gamma(4 - \gamma)S\bar{\theta}}. \quad (\text{A-10})$$

Differentiating $\pi(w)$ and evaluating the derivative at $w = \theta^{**}\gamma S - c_L$ we obtain:

$$\begin{aligned} \pi'(\theta^{**}\gamma S - c_L) &= \frac{(2 + 2\gamma - \gamma^2)c_L - 3\gamma c_H + \gamma(1 - \gamma)^2 S\bar{\theta}}{\gamma(4 - \gamma)(1 - \gamma)S\bar{\theta}} \\ &> \frac{(2 + 2\gamma - \gamma^2)\gamma c_H - 3\gamma c_H + \gamma(1 - \gamma)^2 S\bar{\theta}}{\gamma(4 - \gamma)(1 - \gamma)S\bar{\theta}} \\ &= \frac{(1 - \gamma)(S\bar{\theta} - c_H)}{(4 - \gamma)S\bar{\theta}} > 0, \end{aligned} \quad (\text{A-11})$$

where the first inequality follows because by assumption, $c_L > \gamma c_H$, and the last inequality follows because by assumption $S\bar{\theta} > c_H$ (note that since $\gamma \leq 1$, the denominator in (A-12) is positive). Noting from equation (A-12) that $\pi(w)$ is strictly concave, it follows that it is never optimal to set $w \leq \theta^{**}\gamma S - c_L$, so in equilibrium retailer L is effectively foreclosed.

To show that $w > \theta^{**}\gamma S - c_L$, note that when retailer L is foreclosed, retailer H's profit is given by

equation (A-4) with $\theta_H = p_H(w)/S$. Given the uniform distribution of $F(\theta)$, the optimal price for retailer H, given w , is given by

$$p_H^0(w) = \frac{S\bar{\theta} + c_H + w}{2}. \quad (\text{A-12})$$

Since retailer L is foreclosed, the manufacturer's profit is $(1-F(\theta_H(w)))w$, where $\theta_H(w) = p_H^0(w)/S$. Using equation (A-12), the manufacturer's profit when $w > \theta^{**}\gamma S - c_L$ becomes

$$\pi(w) = \frac{(S\bar{\theta} - c_H - w)w}{2S\bar{\theta}}. \quad (\text{A-13})$$

Differentiating $\pi(w)$, evaluating the derivative at $w = \theta^{**}\gamma S - c_L$, and using the assumptions that $c_L > \gamma c_H$ and $S\bar{\theta} > c_H$, we obtain:

$$\begin{aligned} \pi'(\theta^{**}\gamma S - c_L) &= \frac{(2-\gamma)c_L - c_H + (1-\gamma)^2 S\bar{\theta}}{2(1-\gamma)S\bar{\theta}} > \frac{(2-\gamma)\gamma c_H - c_H + (1-\gamma)^2 S\bar{\theta}}{2(1-\gamma)S\bar{\theta}} \\ &= \frac{(1-\gamma)(S\bar{\theta} - c_H)}{2S\bar{\theta}} > 0. \end{aligned} \quad (\text{A-14})$$

Hence, at the optimum, $w > \theta^{**}\gamma S - c_L$.

To prove the last part of the proposition, note that when θ is distributed uniformly over the interval $[0, \bar{\theta}]$, it follows from equation (6) that $\theta^* = (S\bar{\theta} + c_H)/2S$. Hence, the manufacturer's sales in the vertical integration case are $\bar{\theta} - (S\bar{\theta} + c_H)/2S$. Absent integration and recalling that $w > \theta^{**}\gamma S - c_L$, it follows from equation (A-13) that $w^* = (S\bar{\theta} - c_H)/2$. At w^* , the lowest type served by retailer H is $\theta_H = p_H^0(w^*)/S = (3S\bar{\theta} + c_H)/4S$. Hence the manufacturer's sales are $\bar{\theta} - (3S\bar{\theta} + c_H)/4S$, which is less than in vertical integration case. ■

Proof of Proposition 4: Scheme (i) to implement the vertically integrated outcome is obvious. We therefore only need to consider schemes (ii) and (iii).

Since we wish to implement the vertically integrated outcome, let us evaluate equations (A-6) and (A-7) at the vertically integrated solution, θ_H^{**} and θ_L^{**} . To see why scheme (ii) works, let w^{**} be the value of w that solves equation (A-7). Hence, w^{**} induces retailer L to set θ_L^{**} . However, noting from equation (A-3) that $SM(\theta_H^{**}) = (c_H - c_L)/(1-\gamma)$ and substituting this equality in equation (A-6) and rearranging, yields

$$\frac{f(\theta_H^{**})}{(1-\gamma)S} (c_L + w^{**} - \theta_L^{**} \gamma S) < 0, \quad (\text{A-15})$$

where the inequality follows because $\theta_H^{**} > \theta_L^{**}$ so equation (A-7) implies that $\theta_L^{**} \gamma S > c_L + w^{**}$. Hence, at w^{**} , retailer H would like to set θ_H below θ_H^{**} (and hence p_H below p_H^{**}), implying that there is a need for a minimum RPM on the high quality service to prevent retailer H from lowering p_H below p_H^{**} . To replicate the vertically integrated profit, the manufacturer will charge franchise fees that fully extract the retailers' profits.

Next, consider scheme (iii). If we set $w^{**} = \theta_L^{**} \gamma S - c_L$, then equation (A-6) is satisfied because by equation (A-3), $SM(\theta_H^{**}) = (c_H - c_L)/(1-\gamma)$. On the other hand, the left side of equation (A-7) is now equal to $F(\theta_H^{**}) - F(\theta_L^{**})$ which is strictly positive. Hence, at w^{**} , retailer L would like to set θ_L above θ_L^{**} (and hence p_L above p_L^{**}), implying that there is a need for a maximum RPM on the low quality service to prevent retailer H from raising p_L above p_L^{**} . Since at w^{**} , $p_L^{**} = \theta_L^{**} \gamma S$, the per unit profit of retailer L is $\theta_L^{**} \gamma S - c_L - w^{**} = 0$, implying that w^{**} already extracts all of retailer L's profit. Hence to replicate the vertically integrated profit, the manufacturer only need to charge retailer H a franchise fee that fully extracts retailer H's profit. ■

Proof of Proposition 6: Absent franchise fees, the manufacturer needs to set $w > 0$ (otherwise he makes no money). Let $\theta_H(w)$ and $\theta_L(w)$ be the equilibrium choices of the two retailers as functions of w . Using equations (13) and (14), we obtain:

$$\theta_H(w) = \frac{S\bar{\theta} + c_H + w}{2S}, \quad \theta_L(w) = \frac{\gamma S \theta_{CR} + c_L + w}{2\gamma S}. \quad (\text{A-16})$$

Now suppose that $\theta_H(w) \geq \theta_{CR} \geq \theta_L(w)$. Then, the manufacturer's profit is,

$$\begin{aligned} \pi(w, \theta_{CR}) &= \left(1 - \frac{\theta_H(w)}{\bar{\theta}}\right) w + \left(\frac{\theta_{CR} - \theta_L(w)}{\bar{\theta}}\right) w \\ &= \frac{(\gamma(S\bar{\theta} - c_H - w) + (\gamma S \theta_{CR} - c_L - w)) w}{2\gamma S \bar{\theta}}. \end{aligned} \quad (\text{A-17})$$

Since this expression increases with θ_{CR} , the manufacturer will raise θ_{CR} up to the point where $\theta_{CR} \geq \theta_H(w)$. When $\theta_{CR} \geq \theta_H(w) \geq \theta_L(w)$, the manufacturer's profit is,

$$\begin{aligned}
\pi(w, \theta_{CR}) &= \left(1 - \frac{\theta_{CR}}{\bar{\theta}}\right)w + \left(\frac{\theta_{CR} - \theta_L(w)}{\bar{\theta}}\right)w \\
&= \left(1 - \frac{\gamma S \theta_{CR} + c_L + w}{2\gamma S \bar{\theta}}\right)w.
\end{aligned} \tag{A-18}$$

Now $\pi(w, \theta_{CR})$ decreases with θ_{CR} , so in equilibrium the manufacturer will set $\theta_{CR} = \theta_H(w)$. Similar arguments establish that it is never optimal to have $\theta_{CR} < \theta_L(w)$.

Substituting $\theta_{CR} = \theta_H(w)$ into equation (A-16), and noting that retailer L's sales are positive only if $\theta_H(w) > \theta_L(w)$, it follows that retailer L is active provided that

$$w \leq \bar{w} \equiv \frac{\gamma S \bar{\theta} + \gamma c_H - 2c_L}{2 - \gamma}. \tag{A-19}$$

When, $w \leq \bar{w}$, both retailers are active and the manufacturer's sales are $1 - \theta_L(w)/\bar{\theta}$. When $w > \bar{w}$, only retailer H is active and the manufacturer's sales are $1 - \theta_H(w)/\bar{\theta}$. Therefore the manufacturer's profit is:

$$\pi(w) \equiv \pi(w, \theta_H(w)) = \begin{cases} \frac{(3\gamma S \bar{\theta} - \gamma c_H - 2c_L - (2 + \gamma)w)w}{4\gamma S \bar{\theta}}, & \text{if } w \leq \bar{w}, \\ \frac{(S \bar{\theta} - c_H - w)w}{2S \bar{\theta}}, & \text{if } w > \bar{w}. \end{cases} \tag{A-20}$$

One can check that $\pi(w)$ is continuous at \bar{w} . Since $\pi(w)$ is strictly concave for $w \leq \bar{w}$, it follows that the optimal w for the manufacturer will be equal to or above \bar{w} if $\pi'(w) \geq 0$ for all $w \leq \bar{w}$. Using equation (A-20) we get:

$$\begin{aligned}
\pi'(w) &= \frac{3\gamma S\bar{\theta} - \gamma c_H - 2c_L - 2(2+\gamma)w}{4\gamma S\bar{\theta}} \\
&> \frac{3\gamma S\bar{\theta} - \gamma c_H - 2c_L - 2(2+\gamma)\bar{w}}{4\gamma S\bar{\theta}} \\
&= \frac{\gamma S\bar{\theta}(2-5\gamma) - \gamma c_H(6+\gamma) + 2c_L(2+3\gamma)}{4\gamma S\bar{\theta}(2-\gamma)} \\
&> \frac{(S\bar{\theta} - c_H)(2-5\gamma)}{4S\bar{\theta}(2-\gamma)},
\end{aligned} \tag{A-21}$$

where the last inequality follows because $c_L > \gamma c_H$. Since $S\bar{\theta} > c_H$, it follows that the derivative is positive whenever $\gamma < 2/5$, in which case $w \geq \bar{w}$, so retailer L is effectively foreclosed. ■

Proof of Proposition 7: The first order condition for θ_L^{CR} can be written as

$$\frac{d\pi_L^{CR}(\theta)}{d\theta_L} = f(\theta_L) \left[c_L - \gamma S \left(\theta_L - \frac{F(\theta_{CR}) - F(\theta_L)}{f(\theta_L)} \right) \right] = 0. \tag{A-22}$$

Since the second term inside the square brackets is strictly increasing with θ_L (see footnote 18), equation (A-22) implies that θ_L^{CR} is decreasing with γ . Moreover, equation (A-22) along with equations (6) and (15) imply that at $\gamma = c_L/\theta^*S$, (the lowest permissible value of γ), $\theta_L^{CR} = \theta_{CR}^* = \theta^*$. Since θ^* is independent of γ while θ_L^{CR} is decreasing with γ , it follows that $\theta_L^{CR} < \theta^*$ for all $\gamma > c_L/\theta^*S$. ■

Proof of Proposition 9: Since we restrict attention to cases where $c_L/\gamma S \leq \theta^*$ (entry by retailer L is not blocked) and $c_H \leq c_L/\gamma$ (the ranking of the two services is preserved), the permissible values of c_L are between γc_H and $\theta^*\gamma S$. Under a uniform distribution of consumers' types on the interval $[0, \bar{\theta}]$, $\theta^* = (\bar{\theta}S + c_H)/2S$. Hence, $\gamma c_H \leq c_L \leq \gamma(\bar{\theta}S + c_H)/2$. Now let $\Delta_w \equiv W^{CR} - W(\theta^*)$ be the difference between social welfare with and without CR. Straightforward calculations reveal that $\partial^2 \Delta_w / \partial c_L^2 = (12-\gamma)/(\gamma S(4-\gamma)^2) > 0$; hence Δ_w is a U-shaped function of c_L . Moreover, Δ_w has two roots: the small root is \hat{c}_L , defined in the proposition, and the large root is $\gamma(\bar{\theta}S + c_H)/2$. Hence, $W^{CR} > W(\theta^*)$ for $c_L < \hat{c}_L$ and conversely when $c_L > \hat{c}_L$. ■

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