Retailer's Choice of Product Variety and Exclusive Dealing under Asymmetric Information

by

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Abstract: This paper considers vertical relations between an upstream manufacturer and a downstream retailer that can independently obtain a low-quality, discount substitute. The analysis reveals that under full information the retailer offers both varieties if and only if it is optimal to do so under vertical integration. However, when the retailer is privately informed about demand, then the retailer will offer both varieties even if under vertical integration it is profitable to offer only the manufacturer's product. If the manufacturer can impose exclusive dealing, then it will do so and foreclose the low quality substitute even if under vertical integration it is profitable to offer both varieties.

*Keyword*s: vertical differentiation, information rents, exclusive dealing

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1. Introduction

Downstream retailers sometimes enhance their product variety by offering low quality, discount substitutes to the products produced by upscale manufacturers. For example, supermarkets and drugstores often introduce private labels, whose market share has been growing rapidly in recent years.[1] Stores for electronics and home appliances often offer reputable brands as well as unfamiliar, low priced substitutes. In contrast, upstream manufacturers sometime limit the variety choice of their retailers by imposing exclusive dealing, according to which the upstream manufacturer prohibits its retailer from selling products that competes with the one sold by the manufacturer.

This paper addresses two questions. First, what are retailers' incentives to enhance their variety by offering both qualities instead of just high quality? In particular, whether these incentives differ between vertically integrated or separated industries. This question is of special concern in the context of private labels, because it might be expected that upstream manufacturers' superiority in production will enable them to produce high quality products with lower quality – adjusted costs than the quality- adjusted costs of the private label, thus making the introduction of private labels unprofitable.

The second question relates to the potential incentives that an upstream manufacturer may have to impose exclusive dealing on its retailer, according to which a manufacturer prohibits a retailer from selling substitute brands to those sold by this manufacturer. On one hand, a manufacturer may impose exclusive dealing because of welfare enhancing motivations.[2] But at the same time, a manufacturer that benefits from a leading position in the market may impose exclusive dealing with the sole purpose of foreclosing competing brands.

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[1] The US' Private Label Manufacturers Association (PLMA) reports (based on data from Information Resources, Inc), that between 1998 – 2003, supermarkets' and drug chains' revenues from store brands have increased by 17.9% and 21% respectively, compared to a 14.0% and 13.5% gain respectively in national brand sales over the same period. During 2003 alone, unite sales of store brands in US supermarkets and drug chains increased by 2.2% and 6.5% respectively, versus 1.4% and 0.4% respectively for national brands. Moreover, in 2003, unite market shares of store brands in supermarkets and drug chains where 20.7% and 12.6% respectively. See http://www.plma.com/.

[2] Exclusive dealing may have several welfare enhancing properties. For example, exclusive dealing may induce a retailer to focus its promotional activities on the manufacturer's products and thereby enhance the provision of customers' service. Exclusive dealing can also secure investments made by the manufacturer (such as quality assurance and advertising) by preventing the retailer from "free – riding" on these investments. See Marvel (1982) and Besanko and Perry (1993) for an analysis of this point.

However, this second potential anti-competitive effect of exclusive dealing was challenged by the well-known "Chicago School" for two related reasons.[3] First, if offering a second brand increases the retailer's gross profit, then it will also benefit the manufacturer, that can charge the retailer higher franchise fees. Therefore, if a manufacturer finds it profitable to foreclose a competing brand then it has to be that this brand is a poor substitute to begin with. Second, even if a manufacturer imposes exclusive dealing, the manufacturer will still need to compensate the retailer for the foregone profits from offering the competing brand. Thus it is not clear why exclusive dealing is any better from the manufacturer's viewpoint than offering quantity discounts such that the retailer will independently choose not to sell the competing brand. As Gilbert (2000) points out, the arguments made by the "Chicago School" parallels a more tolerant approach by US courts towards exclusive dealing.[4] Therefore, these arguments beg the question of whether a manufacturer will ever choose to impose exclusive dealing with the sole purpose of foreclosing a competing brand and what is the effect of exclusive dealing on the retailer, consumers and welfare.

This paper studies vertical relations between an upstream manufacturer (M) that produces a high quality product (H) and a downstream retailer (R), when R can obtain at a given cost a low quality substitute (L). For example, the substitute product can be interpreted as a private label, or a low quality product available from a perfectly competitive fringe, such as import.[5]

The model reveals that the answer to the two questions raised above depends crucially on the extent to which the retailer is privately informed about consumers' average willingness to pay. Under full information, M offers a contract that induces R to sell both L and H whenever L is efficient (such that a vertically integrated monopoly chooses to offer both L and H) but induces R to sell only H otherwise. In the later case M does not need to impose exclusive dealing to obtain

[3] For example, Posner (1976, pp. 205) argued that: "it is unlikely that a rational profit-maximizing firm will use exclusive dealing as a method of excluding a competitor. But one cannot be sure that it will never do so." In a somewhat more conclusive statement, Bork (1978, pp. 309) argued that: "there has never been a case in which exclusive dealing or requirements contracts were shown to injure competition."

[4] In the US, exclusive dealing may violate the Clayton Act (Section 3) and the Sherman Act (Section 2). However, due to its potential pro – competitive effects, the per se characterization of exclusive dealing was rejected in *Standard Oil Co. v. United States (Standard Stations)*, 337 U.S. 293, 305 -06 (1949). The rule of reason approach was reaffirmed in *Tampa Elec. Co. v. Nashville Coal Co.,* 365 U.S. 320 (1961). In the recent case of *Republic Tobacco Co. v. North Atlantic Trading Company Inc.* (2004), the court remarked that "Rather than condemning exclusive dealing, courts often approve them because of their procompetitive benefits." For a discussion on the potential pro and anti competitive effects of exclusive dealing and the history of its legal statues in the US, see Areeda and Kaplow (1997) and Sullivan and Hovenkamp (2003).

[5] In the Conclusion I offer some remarks on the robustness of the results in the case where the market for the low quality product is not perfectly competitive.

exclusivity. The intuition for this result is that M captures R's entire added value from selling H and thereby whishes to maximize R's gross profit. This result implies that under full information, the decision whether to offer low quality substitutes such as private labels is not effected by the vertical structure. Moreover, this result supports the argument that exclusive dealing does not offer any advantage in foreclosing a competing brand.

Then I turn to consider the case where R is privately informed about consumers' average willingness to pay. If R is free to sell L, then R is privately informed not only regarding R's potential revenues from selling H, but also on whether a certain contract induces R to sell additional unites of L or not. The revelation mechanism that M offers R should take into account the possibility that by understating consumers' willingness to pay, R can mislead M into believing that R intends to sell H exclusively while in practice R will sell both brands and earn additional profit from selling L. Moreover, even if M can reveal R's intention to sell L, R can mislead M on its potential revenues from L and again earn additional profits. The model shows that if the asymmetric information problem is significant and M is not allowed to use exclusive dealing, then R will offer both H and L even if L is unprofitable under vertical integration. The benefit of offering L from R's viewpoint is that it provides R with additional informational advantage and thereby increases R's information rents.

This result indicates that under asymmetric information retailers will expand their product variety by offering brands which are unprofitable under full information, because it enables retailers to gain informational leverage over manufacturers.

This result also provides an explanation for why M may use the additional instrument of exclusive dealing. The model reveals that if exclusive dealing is possible, then M will impose exclusive dealing whenever L is unprofitable under vertical integration, and may impose exclusive dealing even if L is profitable. The intuition for this result is that since selling L increases R's information rents, M will impose exclusive dealing even though it reduces total industry profits. Clearly, exclusive dealing increases M's profit, but nonetheless it reduces the total industry profits as well as consumers' surplus. For antitrust policy, these results indicate that exclusive dealing should be suspected for being anti-competitive when the market is subject to a significant asymmetric information problem.

Most previous literature on exclusive dealing focused on exclusive dealing as a choice of channel distribution according to which each manufacturer finds it optimal to sell through its own

retailer rather than through a common retailer.[6] Typically, such strategy does not lead to market foreclosure, which is the focus of this paper. In the context of a single retailer that serves two vertically differentiated upstream firms (such that exclusive dealing exclude one brand from the market), Mathewson and Winter (1987) consider exclusive dealing under full information when the upstream firms can only use linear contracts. They find that exclusive dealing can increase social welfare because it induces the leading manufacturer to lower its wholesale price. O'Brien and Shaffer (1997) extend Mathewson and Winter's paper to allow for nonlinear contracts, and show that exclusive dealing does not offer the manufacturers any advantage that cannot be obtained with nonlinear contracts. Bernheim and Whinston (1998) show that exclusive dealing as a device for foreclosing a rival brand may emerge due to informational issues. This paper differs from theirs in that they assume uncertainty regarding demand by both the two manufacturers and the retailer. Furthermore, the retailer is risk averse, and thereby it is optimal for the manufacturers to share this risk with the retailer. They show that upstream competition creates an externality in the provision of risk bearing, which in turn creates the potential for exclusive dealing. In the extreme case in which the two brands are perfect substitutes, the externality is significant and all equilibria are exclusive, while if the two products are independent, then any undominated equilibrium entails common representation. In contrast, in this paper the motivation for exclusive dealing is not to mitigate externality in the provision of risk bearing but to reduce the retailer's informational advantage. As a result, exclusive dealing in this paper is more likely to occur if products are more differentiated, instead of less differentiated as in Bernheim and Whinston. Moreover, Bernheim and Whinston finds that banning exclusive dealing in the context of uncertainty is inefficient because it prevents the less risk averse player, the manufacturer, to bear some of the risk. In contrast, in this paper banning exclusive dealing increases both industry profits and consumers' surplus.[7]

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[6] See Bernheim and Winston (1985), Dobson and Waterson (1996) and Moner-Colonques, Sempere-Monerris and Urbano (2004) in the context of full information and Gal-Or (1991) and Martimort (1996) in the context of asymmetric information.

[7] The use of exclusivity provisions was also studied when one manufacturer benefits from a first-mover advantage. Aghion and Bolton (1987) show that an incumbent can use its first-mover advantage to foreclose an efficient entrant. However, in their model, the buyer whishes to buy only one indivisible unit. Thereby, exclusive dealing in their model is exogenous because the supplier cannot choose to accommodate its rival. Rasmusen et al (1991), Segal and Whinston (2000) and Fumagalli and Motta (2005) show that exclusionary contract emerges when the entrant needs to reach a minimum efficient scale to profit from entering the market. In contrast, in this paper exclusionary occurs even though L is already available at the market.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 considers a full information benchmark. Section 4 considers asymmetric information when the manufacturer cannot impose exclusive dealing. The equilibrium under exclusive dealing is analyzed in Section 5. Section 6 offers concluding remarks. All proofs are in the Appendix.

2. The Model

Consider an upstream manufacturer (M) that produces a high quality product (H) at marginal cost c_H. M does not have the ability to sell directly to final consumers and needs to rely on a downstream retailer (R) that can distribute H at zero retail cost. In addition to selling H, R can also sell a low quality substitute (L) that R can obtain at marginal cost of c_L, where $c_L < c_H$. For example, H can represent a national brand produced by a reputable manufacturer while L can represent a private label produced exclusively by the retailer. Alternatively, L can represent a low quality product that R can buy from a competitive fringe (such as import) at a given price of c_L.

From to the demand side, 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), I assume that given the final prices of H and L, p_H and p_L respectively, the utility of a consumer whose marginal willingness to pay for quality is v, is given by

$$u = \begin{cases} v - p_H, & \text{buys from } H, \\ \gamma v - p_L, & \text{buys from } L, \\ 0, & \text{otherwise,} \end{cases} \tag{1}$$

where γ $(0 < \gamma < 1)$ measures the relative quality of L from the consumers' viewpoint (while the quality of H is normalized to 1). Alternatively, γ can measure the reputation of the L product, where $\gamma < 1$ implies that L is less reputable than H. Suppose that v is distributed uniformly along the interval $[\theta - 1, \theta]$, where $\min\{2 + c_H, 2 + c_L/\gamma\} \geq \theta \geq 1$. Thus θ measures the consumers' average willingness to pay for quality. The restrictions on θ ensure that the market is never fully covered. In addition, I assume that $\theta - c_H > \gamma\theta - c_L > 0$. This assumption implies that, priced at marginal cost, at least the highest type consumer (with $v = \theta$) has a positive utility from buying both products although this consumer prefers to buy H. As I will show later on, this assumption rule out the uninteresting case where H is never offered.

It is straightforward to show that in order to sell both L and H, p_L should be sufficiently lower then p_H in the sense that $p_H > p_L/\gamma$. This inequality ensures that high type consumers with $v \in [(p_H -$

$p_L)/(1-\gamma)$, θ] buy H, intermediate type consumers with $v \in [p_L/\gamma, (p_H - p_L)/(1-\gamma)]$ buy L, and low type consumers with $v \leq p_L/\gamma$ do not buy at all. Rearranging these terms, the inverse demand functions facing R are: [8]

$$p_H(q_L, q_H; \theta) = \theta - q_H - \gamma q_L, \qquad p_L(q_L, q_H; \theta) = \gamma(\theta - q_H - q_L). \qquad (2)$$

If only H is offered, or if both H and L are offered but $p_H > p_L/\gamma$ (in which case all consumers who buy prefer to buy H), then all consumers with $v \in [p_H, \theta]$ buy H and the inverse demand function is $p_H(0, q_H; \theta) = \theta - q_H$. Likewise, if only L is offered then all consumers with $v \in [p_L/\gamma, \theta]$ buy L and the inverse demand function is $p_L(q_L, 0; \theta) = \gamma(\theta - q_L)$.

Under vertical integration (when one firm produces a distributes both qualities to final consumers), q_H and q_L are chosen to maximize the sum of industry profits,

$$\pi(q_L, q_H; \theta)^{VI} = \begin{cases} \left(p_H(q_L, q_H; \theta) - c_H\right)q_H + \left(p_L(q_L, q_H; \theta) - c_L\right)q_L, & \text{if } q_L > 0, \\ \left(p_H(0, q_H; \theta) - c_H\right)q_H, & \text{otherwise.} \end{cases} \qquad (3)$$

The vertical integration quantities are

$$q_H(\theta)^* = \begin{cases} \dfrac{(\theta - c_H) - (\gamma\theta - c_L)}{2(1-\gamma)}, & \text{if } \gamma c_H > c_L, \\ \frac{1}{2}(\theta - c_H), & \text{otherwise,} \end{cases} \qquad q_L^* = \begin{cases} \dfrac{c_H - c_L/\gamma}{2(1-\gamma)}, & \text{if } \gamma c_H > c_L, \\ 0 & \text{otherwise.} \end{cases} \qquad (4)$$

Note that since by assumption, $\theta - c_H > \gamma\theta - c_L > 0$, $q_H(\theta)^* > 0$. However, a vertically integrated monopoly will offer L if and only if $c_L/\gamma < c_H$. Intuitively, even though consumers always value L less than H, L is nonetheless *efficient* if its quality-adjusted costs, c_L/γ, is lower than the quality-adjusted cost of H, c_H (where recall that the quality of H is normalized to 1). Otherwise, L is *inefficient* and a vertically integrated monopoly will not offer it. The gap $c_L/\gamma - c_H$ can be interpreted as a measure of the inefficiency of L: whenever $c_L/\gamma - c_H > 0$ (L is inefficient), as c_L/γ

[8] I am going to maintain the assumption of a single retailer throughout this paper and thereby considering a quantity setting retailer yields identical results as a price setting firm. Nonetheless, considering a quantity setting firm facilitates the analysis and enables me to directly present the conditions for offering positive quantities of both L and H.

- c_H increases, L becomes more inefficient, and whenever $c_H - c_L/\gamma > 0$ (L is efficient), as $c_H - c_L/\gamma$ increases L becomes more efficient.[9] In what follows, I will allow for both an efficient and inefficient L, because this will illustrates how the decision on whether to sell L or not depends on whether L is efficient. Finally, note from (4) that the assumption $\min\{2 + c_H, 2 + c_L/\gamma\} \geq \theta \geq 1$ ensures that $q_H(\theta)^* + q_L(\theta)^* < 1$, implying that the market is never fully covered. Substituting (4) back into (3) yields the vertical integration profit, $\pi(\theta)^*$.

3. Full Information Benchmark

Now suppose that M and R are two independent firms, with M being the sole producer of H. To study the full information case, consider the following two stage game. In stage 1, M makes a take-it-or-leave-it-offer $\{q_H, T\}$, where q_H is a fixed quantity of H and T is the associated payment form R to M. At this point M can also impose exclusive dealing, according to which R is prohibited from selling L. In stage 2, if R accepts M's offer then R chooses the optimal quantities of H and L (whenever M did not impose exclusive dealing). If R rejects M's offer, R offers only L to final consumers.

   Suppose first that M is not allowed to impose exclusive dealing. Solving the game backwards, note that in stage 2 q_H should be binding on R, because if M anticipates that R will set a lower quantity than q_H, then M can benefit from offering a lower q_H (that will allow M to save cost) without changing T. Therefore, if R accepts the offer $\{q_H, T\}$, R will sell all the unites of H, and set q_L as to maximize

$$\pi_R(q_L, q_H; \theta) = \begin{cases} \left(p_L(q_L, q_H; \theta) - c_L\right)q_L + p_H(q_L, q_H; \theta)q_H - T, & if\ q_L > 0, \\ p_H(0, q_H; \theta)q_H - T, & otherwise. \end{cases} \quad (5)$$

Maximizing (5) with respect to q_L yields

$$q_L(q_H; \theta) = \begin{cases} \dfrac{\gamma\theta - c_L}{2\gamma} - q_H, & if\ q_H < q_H^C(\theta) \equiv \dfrac{\gamma\theta - c_L}{2\gamma}, \\ 0, & otherwise. \end{cases} \quad (6)$$

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[9] Johnson and Mayatt (2003) derive similar condition in the context of a quantity-setting monopoly that can offer n different qualities, q_i, at marginal cost c_i. They show that the monopoly will offer only the highest quality if c_i/q_i is decreasing with i, and they interpret this case as an increasing return to quality.

Equation (6) indicates that when R accepts M's offer, there is a cutoff level of q_H, denoted by $q_H^C(\theta)$, such that R will offer L if and only if $q_H < q_H^C(\theta)$. Intuitively, since q_H should be binding in equilibrium, if M offers a small q_H, then R will offer additional unites of L. For high values of q_H, R will settle for selling only H. Substituting (6) back into (5), R's profit from accepting M's contract is

$$\pi_R(q_H;\theta) = \begin{cases} \pi_{HL}(q_H;\theta) - T, & if\ q_H < q_H^C(\theta), \\\\ \pi_H(q_H;\theta) - T, & if\ q_H \geq q_H^C(\theta), \end{cases} \tag{7}$$

where

$$\pi_{HL}(q_H;\theta) = \big(p_L(q_L(q_H;\theta),q_H;\theta) - c_L\big)q_L(q_H;\theta) + p_H(q_L(q_H;\theta),q_H;\theta)q_H, \tag{8}$$

$$\pi_H(q_H;\theta) = p_H(0,q_H;\theta)q_H. \tag{9}$$

If R rejects M's offer, R offers only L and earns

$$\pi_L(\theta) \equiv \max_{q_L}(p_L(q_L,0;\theta) - c_L)q_L = \frac{(\gamma\theta - c_L)^2}{4\gamma}.$$

Therefore, in stage 2 R accepts M's offer as long as $\pi_R(q_H;\theta) > \pi_L(\theta)$.

Turning to stage 1, M's problem is to set $\{q_H,T\}$ as to maximize $\pi_M = T - c_H q_H$, subject to $\pi_R(q_H;\theta) \geq \pi_L(\theta)$. Substituting the constraint into M's profit function and rearranging, yields that M will set q_H as to maximize

$$\pi_M(q_H;\theta) = \begin{cases} \big(p_L(q_L(q_H;\theta),q_H;\theta) - c_L\big)q_L(q_H;\theta) \\\\ + \big(p_H(q_L(q_H;\theta),q_H;\theta) - c_H\big)q_H - \pi_L(\theta), & if\ q_H < q_H^C(\theta), \\\\ \big(p_H(0,q_H;\theta) - c_H\big)q_H - \pi_L(\theta), & if\ q_H \geq q_H^C(\theta). \end{cases} \tag{10}$$

Note that (10) is identical to the profit function under vertical integration (see (3)), with the sole exception that in (3) a vertically integrated monopoly sets both quantities directly while in (10) M can only set q_H anticipating the behavior of R. Moreover, if M imposes exclusive dealing, M's profit differs from (10) only in that M can set $q_H < q_H^C(\theta)$, and nonetheless earn the second line in (10), instead of the first line. For $q_H > q_H^C(\theta)$, exclusive dealing has no force (M earns the second line in (10) with or without exclusive dealing) because R will choose not to sell L even without the restriction. Maximizing (10) obtains the following Proposition:

Proposition 1: *Under full information, M sets $\{q_H, T\} = \{q_H(\theta)^*, \pi_R(q_H(\theta)^*; \theta) - \pi_L(\theta)\}$ and R sets the vertical integration quantities. In equilibrium, R earns $\pi_L(\theta)$ and M earns $\pi(\theta)^* - \pi_L(\theta)$. Moreover, M cannot benefit from imposing exclusive dealing.*

Proposition1 shows that under full information, R's ability to sell low quality substitutes (such as private labels or unfamiliar imported products) changes the way profits are divided between M and R, but have no effect on market performance or product variety in that the equilibrium quantities are identical to those of a vertically integrated monopoly. Moreover, Proposition 1 shows that in the context of this model, the arguments made by the "Chicago School" against the anti – competitive effects of exclusive dealing are justified under full information.

The intuition for Proposition 1 is that since M can truthfully anticipate whether the contract induces R to offer both L and H and since M has full information regarding R's reservation utility, $\pi_L(\theta)$, M will set q_H to maximize total industry profits and will use T to capture all of R's added gross profit from selling H regardless of whether L is efficient or not. Furthermore, M cannot benefit from imposing exclusive dealing on R because of two reasons. First, if L is efficient then M finds it optimal to allow R to sell both H and L as this increases industry profits and enables M to extract higher fees from R. Second, if L is inefficient, then M can foreclose L by setting $q_H > q_H^C(\theta)$ such that R independently chooses not to sell L. Imposing exclusive dealing in this case does not provide M with any additional advantage because M will have to leave R with its reservation utility, $\pi_L(\theta)$, regardless of whether M imposed exclusive dealing or not.

4. Non-exclusive Contract under Asymmetric Information

Since retailers have direct interaction with final consumers while manufacturers are mostly engage in the production activities, it is natural to expect that retailers have more accurate information regarding consumers' willingness to pay than manufacturers. In this section I consider the case in which R has better knowledge about consumers' demand than M. Moreover, I assume that due to antitrust laws, M cannot impose exclusive dealing on R, and thus M is restricted to nonlinear contracts (the case of exclusive dealing is analyzed in the next section). The main result of this section is that unlike the full information benchmark, under asymmetric information R may offer both L and H even if L is inefficient (and not offered under full information).

In what follows, suppose that R is privately informed about consumers' average willingness to pay for the two qualities, θ and that θ is distributed along the interval $[\theta_0, \theta_1]$ according to a smooth distribution function $f(\theta)$ and a cumulative distribution function $F(\theta)$. I make the standard assumption that $H(\theta) \equiv (1- F(\theta))/f(\theta)$ is non-increasing. Following the revelation principal I focus on fully revealing mechanisms. In order to induce R to truthfully reveal its private information, M offers a menu, $\{q_H(\theta), T(\theta)\}$, R reports $\widetilde{\theta}$ and receives the corresponding pair $\{q_H(\widetilde{\theta}), T(\widetilde{\theta})\}$ from the menu (whenever necessary, I will denote R's report as $\widetilde{\theta}$ in order to distinguish R's report from the true θ).

From the previous section it follows that given that R reported some $\widetilde{\theta}$ and received the corresponding $q_H(\widetilde{\theta})$, R sells H exclusively if and only if $q_H(\widetilde{\theta}) > q_H^C(\theta)$ and sells $q_L(q_H(\widetilde{\theta});\theta)$ unites of L otherwise, where $q_H^C(\theta)$ and $q_L(q_H(\widetilde{\theta});\theta)$ are given by (6). Thereby, R's profit given R's report, $\widetilde{\theta}$, and the true θ is

$$\pi_R(\widetilde{\theta};\theta) = \begin{cases} \pi_H(q_H(\widetilde{\theta});\theta) - T(\widetilde{\theta}), & \text{if } q_H(\widetilde{\theta}) \geq q_H^C(\theta), \\ \\ \pi_{HL}(q_H(\widetilde{\theta});\theta) - T(\widetilde{\theta}), & \text{if } q_H(\widetilde{\theta}) < q_H^C(\theta), \end{cases} \tag{11}$$

where $\pi_{HL}(q_H(\widetilde{\theta});\theta)$ and $\pi_H(q_H(\widetilde{\theta});\theta)$ are given by (8) and (9). M's problem is to set the optimal menu $\{q_H(\theta), T(\theta)\}$ as to maximize:

$$\max_{\{T(\theta),q_H(\theta)\}} \int_{\theta_0}^{\theta_1} (T(\theta) - c_H q_H(\theta)) f(\theta) d\theta, \tag{12}$$

$$\text{s.t. } (IC) \ \pi_R(\theta;\theta) > \pi_R(\widetilde{\theta};\theta), \quad \forall \theta, \widetilde{\theta} \in [\theta_0, \theta_1],$$

$$(IR) \ \pi_R(\theta;\theta) > \pi_L(\theta), \qquad \forall \theta \in [\theta_0, \theta_1],$$

where *IC* and *IR* are the incentive compatibility and individual rationality constraints. Note that R's ability to sell L affects this contract design problem in two ways. First, *IR* should take into account that R can sell L *instead* of selling H (by rejecting M's contract altogether) and earn $\pi_L(\theta)$ which depends on R's private information. Thus, this problem has the well-known feature of privately informed agent with type-dependent reservation utility.[10] Second, *IC* should take into

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[10] See Biglaiser and Mezzetti (1993), Maggi and Rodriguze-Clare (1995) and Jullien (2000).

account that R can sell L in *addition* to selling H. This ability affects *IC* because as in under full information, R sells both H and L whenever R buys $q_H(\widetilde{\theta}) < q_H^C(\theta)$ and sells only H otherwise. However, now for a given report, $\widetilde{\theta}$, and a given associated $q_H(\widetilde{\theta})$, R is privately informed on whether this $q_H(\widetilde{\theta})$ is higher or lower than $q_H^C(\theta)$ (which is a function of the true value of θ) and thereby R is privately informed on whether this $q_H(\widetilde{\theta})$ induces R to sell both H and L or just H. This in turn implies that by misreporting the true value of θ, R can potentially report some $\widetilde{\theta}$ that mislead M into believing that R does not intend to sell L (namely, $q_H(\widetilde{\theta}) < q_H^C(\widetilde{\theta})$), while in practice R will sell both brands and benefit from the additional profit from selling L. Moreover, even if M knows that a certain $q_H(\widetilde{\theta})$ induces R to sell L, R is still privately informed bout $q_L(q_H(\widetilde{\theta});\theta)$, implying that by misreporting θ, R does not only mislead M regarding the potential profit that R can obtain from selling H, but also regarding the potential quantity and profits that R can obtain from selling L.

To solve (11), I follow previous literature on mechanism design problems when the agent has a type − dependent reservation utility and adjust it to allow for the possibility that R may offer both H and L for some values of $\theta \in [\theta_0, \theta_1]$, while for others, $\hat{\theta} \in [\theta_0, \theta_1]$, $\hat{\theta} \neq \theta$, R offers only H. Let $U(\widetilde{\theta};\theta) = \pi_R(\widetilde{\theta};\theta) - \pi_L(\theta)$, and let $U(\theta;\theta) \equiv U(\theta)$ dente the information rents. Differentiating (11) and using the envelope theorem, the marginal information rents are

$$U'(\theta) = \begin{cases} q_H(\theta) - \frac{1}{2}(\gamma\theta - c_L), & \text{if } q_H(\theta) \geq q_H^C(\theta), \\ q_H(\theta)(1-\gamma), & \text{if } q_H(\theta) \leq q_H^C(\theta). \end{cases} \tag{13}$$

Next I turn to find sufficient conditions that ensure *IR* and *IC*. Staring with *IR*, note that R has an incentive to understate θ in order to mislead M into believing that the benefit of accepting its contract and selling H are low, but at the same time R has an incentive to overstate θ in order to mislead M into believing that its reservation utility from selling only L, $\pi_L(\theta)$, is high. Nonetheless Lemma 1 shows that the first effect always dominates in that $U'(\theta) > 0$.[11] Intuitively, since by assumption both $\pi_{HL}(q_H(\theta);\theta) > \pi_L(\theta)$ and $\pi_H(q_H(\theta);\theta) > \pi_L(\theta)$, R has little to gain from overstating $\pi_L(\theta)$, compared to the loss that R will have to incur from the fact that by doing so R also overstate $\pi_{HL}(q_H(\theta);\theta)$ or $\pi_H(q_H(\theta);\theta)$. Since $U'(\theta) > 0$, *IR* always binds at θ_0 and thereby

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[11] In the first line in (13), $U'(\theta) > 0$ follows because $q_H(\theta) \geq q_H^C(\theta) > (\gamma\theta - c_L)/2$ and in the second line $U'(\theta) > 0$ follows because by assumption $1 > \gamma$.

there are no countervailing incentives in equilibrium. Next consider *IC*. Using (11) and the definition of $U(\theta)$, M will charge

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T(\theta) = \begin{cases} \pi_H(q_H(\theta);\theta) - \pi_L(\theta) - \int_{\theta_0}^{\theta} U'(\hat{\theta})d\hat{\theta}, & \text{if } q_H(\theta) \geq q_H^C(\theta), \\ \pi_{HL}(q_H(\theta);\theta) - \pi_L(\theta) - \int_{\theta_0}^{\theta} U'(\hat{\theta})d\hat{\theta}, & \text{if } q_H(\theta) < q_H^C(\theta). \end{cases} \tag{14}
$$

where $U'(\theta)$ in the first and second line of $T(\theta)$ is given by the first and second line in (13) respectively. The combination of (11), (13) and (14) shows that *IC* should account for four potential cases. In the first case R reports $\tilde{\theta}$ such that $q_H(\tilde{\theta}) > \max\{q_H^C(\theta), q_H^C(\tilde{\theta})\}$. Here, given the report, M has a correct prediction that $q_H(\tilde{\theta})$ induces R to sell only H and thereby M charges the first line of $T(\theta)$ and R earns the first line in (11). Likewise, in the second case R reports $\tilde{\theta}$ such that $q_H(\tilde{\theta}) < \min\{q_H^C(\theta), q_H^C(\tilde{\theta})\}$ and M has a correct prediction that $q_H(\tilde{\theta})$ induces R to sell both H and L and thereby M charges the second line of $T(\theta)$ and R earns the second line in (11). In contrast, in the third case R reports $\tilde{\theta}$ such that $q_H^C(\theta) > q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$. Here, M has an incorrect prediction that R sells only H and thereby M charges the first line of $T(\theta)$ while R sells both H and L and earns the second line in (11). Likewise, in the forth case R reports $\tilde{\theta}$ such that $q_H^C(\theta) < q_H(\tilde{\theta}) < q_H^C(\tilde{\theta})$. M has an incorrect prediction that R sells both H and L and thereby M charges the second line of $T(\theta)$ while R sells only H and earns the first line in (11). In the Lemma below I show that the non-decreasing $q_H(\theta)$ ensures that *IC* covers all four possibilities.

Lemma 1: *Suppose that $q_H(\theta)$ is continuous, and twice differentiable except for the intersection points with $q_H^C(\theta)$. Then, necessary and sufficient conditions for IR and IC are $U(\theta_0) = 0$ and $q_H(\theta)$ is non-decreasing in θ.*

Substituting (14) into (12) and rearranging, M's problem is to maximize

$$
\underset{q_H(\theta)}{Max} \int_{\theta_0}^{\theta_1} \left[\pi^M(q_H(\theta);\theta) - H(\theta)U'(\theta) \right] f(\theta)d\theta, \tag{15}
$$

s.t. the constraints of Lemma 1, where $\pi^M(q_H(\theta);\theta)$ is given by (10). Thus M's problem is to maximize the full information profits minus the information rents multiplied by their costs from M's viewpoint, $H(\theta)$. Let $q_H(\theta)^{NED}$ and $q_H(\theta)^{ED}$ denote the $q_H(\theta)$ that maximizes the term in the squared brackets for $q_H(\theta) < q_H^C(\theta)$ and $q_H(\theta) > q_H^C(\theta)$ respectively, where

$$q_H^{NED}(\theta) = \frac{\theta - c_H - (\gamma\theta - c_L) - H(\theta)(1-\gamma)}{2(1-\gamma)}, \quad q_H^{ED}(\theta) = \frac{\theta - c_H - H(\theta)}{2}, \tag{16}$$

and let $q_H(\theta)^{**}$ denotes the solution to (15). To facilitate the discussion, I present the characteristics of the optimal solution to (15) in two separate propositions for the cases of efficient and inefficient L. I begin by solving (15) under the assumption that L is inefficient:

Proposition 2: *Suppose that L inefficient and that R is privately informed about* θ.

(i)   *If* $H(\theta_0) < c_L/\gamma - c_H$, *then M offers* $q_H(\theta)^{**} = q_H^{ED}(\theta)$ *and R offers only H for* $\forall\theta \in [\theta_0, \theta_1]$.

(ii) *If* $c_L/\gamma - c_H < H(\theta_0) < (c_L/\gamma - c_H)/(1 - \gamma)$, *then there is a cutoff,* $\overline{\theta}$, *where* $H(\overline{\theta}) = c_L/\gamma - c_H$, *such that M offers:*

$$q_H(\theta)^{**} = \begin{cases} q_H^C(\theta), & if\ \theta \in [\theta_0, \overline{\theta}], \\ q_H^{ED}(\theta), & if\ \theta \in [\overline{\theta}, \theta_1], \end{cases} \tag{17}$$

and R offers only H for $\forall\theta \in [\theta_0, \theta_1]$.

(iii) *If* $(c_L/\gamma - c_H)/(1 - \gamma) < H(\theta_0)$, *then there is a cutoff,* $\underline{\theta}$, *where* $H(\underline{\theta}) = (c_L/\gamma - c_H)/(1 - \gamma)$, *such that M offers:*

$$q_H(\theta)^{**} = \begin{cases} q_H^{NED}(\theta), & if\ \theta \in [\theta_0, \underline{\theta}], \\ q_H^C(\theta), & if\ \theta \in [\underline{\theta}, \overline{\theta}], \\ q_H^{ED}(\theta), & if\ \theta \in [\overline{\theta}, \theta_1], \end{cases} \tag{18}$$

and R offers both H and L for $\theta \in [\theta_0, \underline{\theta}]$ *and offers only H for* $\theta \in [\underline{\theta}, \theta_1]$. *Moreover,* $\underline{\theta}$ *is increasing with* γ *and* c_H *and decreasing with* c_L.

The main result of Proposition 2 is that as long as $(c_L/\gamma - c_H)/(1 - \gamma) < H(\theta_0)$, asymmetric information induces R to sell an inefficient L. The intuition for Proposition 2 is the following. Under asymmetric information, M has the well-known incentive to distort $q_H(\theta)$ downwards because doing so makes it less attractive for R to understate θ and thereby reduces R's

information rents. The higher the costs of information rents, $H(\theta)$, it follows from (15) that the distortion is more significant ($q_H(\theta)^{**}$ decreases). Now, recall that under full information, if L is inefficient then $q_H(\theta)^* > q_H^C(\theta)$ such that R chooses not to sell L. Part (i) indicates that in the case where $H(\theta_0) < c_L/\gamma - c_H$, the downwards distortion in $q_H(\theta)$ is modest such that $q_H^{ED}(\theta)$ is still higher than $q_H^C(\theta)$ for all θ, and R offers only H, as shown in Panel (a) of Figure 1. Intuitively, in this case L is highly inefficient because the gap in the quality adjusted cost, $c_L/\gamma - c_H$ is high, while the cost of the information rents are low such that M has a low incentive to distort $q_H(\theta)$. As a result, the asymmetric information is not significant enough compared to the inefficiency of L in order to induce R to sell L.

In contrast, in parts (ii) and (iii) $H(\theta_0)$ is sufficiently high such that for low values of θ, $q_H^{ED}(\theta)$ falls below $q_H^C(\theta)$ which induces R to sell both H and L. This however raises a new problem for M, because whenever R sells both L and H, R can understate θ and thereby mislead M not only regarding the revenues from H, but also regarding the quantity of L that R sells, $q_L(q_H(\tilde{\theta});\theta)$, which is an increasing function of θ. Thus, by distorting $q_H(\theta)$ downwards and below $q_H^C(\theta)$, M on one hand reduces R's information rents because quantity is lower, but at the same time increases R's information rents because R gains an additional information advantage from selling L. Now, Panel (b) of Figure 1 shows that in part (ii), $H(\theta_0)$ is not too large and thereby these two effects balance each other such that for $\theta \in [\theta_0, \bar{\theta}]$, M will set $q_H(\theta)^{**} = q_H^C(\theta)$. Panel (c) illustrates the case of part (iii), in which $H(\theta_0)$ is high enough such that the two effects balance each other only for $\theta \in [\underline{\theta}, \bar{\theta}]$, while for $\theta \in [\theta_0, \underline{\theta}]$, the first effect dominates and M will set $q_H^{NED}(\theta) < q_H^C(\theta)$ although doing so induces R to sell both L and H.

Next, I turn to the case where L is efficient:

Proposition 3: *Suppose that L is efficient and that R is privately informed about θ. Then, M offers $q_H(\theta)^{**} = q_H^{NED}(\theta)$ and R offers both L and H for all $\theta \in [\theta_0, \theta_1]$.*

The intuition for Proposition 3 is that as in the case of inefficient L, M whishes to distort $q_H(\theta)$ below the full information quantity in order to reduce R's information rents. However, since L is efficient, R sells both H and L even under full information, and the downwards distortion in $q_H(\theta)$ only increases the incentive to sell both L and H and thereby both qualities are offered for all $\theta \in [\theta_0, \theta_1]$.

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Proposition 3 along with parts (ii) and (iii) of Proposition 2 indicates that asymmetric information induces R to expand the use of L in the sense that R offers L whenever L is efficient and may also sell L when L is inefficient. These results have two implications. First, they provide an explanation for why retailers offer low quality discount substitutes (such as private labels or unfamiliar imported products). In particular, the model predicts that low quality substitutes are offered even though they are inefficient when asymmetric information is significant and when consumers' average willingness to pay is low such that it falls below manufacturers' expectations (since M expect that $\theta \in [\theta_0, \theta_1]$, R sells L if the actual realization of θ is on the lower part of M's expectations).[12] Second, the results obtained in this section indicate that under asymmetric information M will not use a nonlinear contract alone to exclude an inefficient product, which implies that unlike the full information benchmark, M may benefit from directly imposing exclusive dealing on R.

5. Exclusive Dealing

In what follows, suppose that M can impose exclusive dealing by requiring R to focus solely on selling H. The main result of this section is that M benefits from imposing exclusive dealing because this reduces R's information rents. As a result, M will impose exclusive dealing whenever L is inefficient and may also impose exclusive dealing if L is efficient if asymmetric information is significant enough.

With the additional instrument of exclusive dealing, suppose that M offers a menu of $\{T(\theta),$ $q_H(\theta), ED(\theta)\}$, where $ED(\theta) = 1$ if the contract includes an exclusive dealing clause for this particular θ and $ED(\theta) = 0$ otherwise. Whenever $ED(\theta) = 1$, R is restricted to sell only H regardless of whether $q_H(\theta)$ is higher or lower than $q_H^C(\theta)$. For $ED(\theta) = 0$, R can choose between offering both H and L or just H, and in this R will sell L if and only if $q_H(\theta) < q_H^C(\theta)$. Thus, R's profit given R's report $\tilde{\theta}$, and the true θ is given by (11), where the first line in (11) now holds even if $q_H(\tilde{\theta}) < q_H^C(\theta)$ as long as $ED(\theta) = 1$. Building on Lemma 1 and the analysis of the previous section, it is clear that if for a certain θ M sets $ED(\theta) = 0$, then the marginal information rents for this particular θ are given by (13). Likewise, if for a certain θ M sets $ED(\theta) = 1$, then the marginal information rents are given by the first line in (13), which holds for both $q_H(\theta) \leq q_H^C(\theta)$

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[12] This result differs from Mills (1995) who shows that a retailer offers an inefficient private label if consumers have a high (rather than low) average willingness to pay. The difference between the results emerge because Mills focus only on full information and show that a retailer will sell private label in order to mitigate the double marginalization problem. Since a high demand enhances the double marginalization problem, private labels emerge when demand is high. In contract, in this paper R sells L because of the asymmetric information problem that is grater for low values of θ.

and $q_H(\theta) > q_H{}^C(\theta)$.[13] Thereby, it follows that if for a certain θ M sets $ED(\theta) = 0$, M will set $q_H(\theta)$ $= q_H{}^{ED}(\theta)$ and $q_H(\theta) = q_H{}^{NED}(\theta)$ for $q_H(\theta) > q_H{}^C(\theta)$ and $q_H(\theta) < q_H{}^C(\theta)$ respectively. Likewise, if for a certain θ M sets $ED(\theta) = 1$, M will set $q_H(\theta) = q_H{}^{ED}(\theta)$. Thus, M's problem under exclusive dealing collapses to setting the optimal $ED(\theta)$ to maximize expected vertical integration profits minus R's information rents.

As in Section 4, I distinguish between the optimal solution under efficient and inefficient L. Starting with the case in which L is inefficient, recall from Proposition 2 that if the asymmetric information problem is insignificant, then R's ability to sell L does not impose a binding constraint on the optimal contract, thus exclusive dealing is superfluous. I therefore focus on the more interesting case in which absent exclusive dealing, R's ability to offer L is a binding constraint on the equilibrium contract.

Proposition 4: *Suppose that L is inefficient and that c_L/γ - $c_H < H(\theta_0)$ (absent exclusive dealing, L impose a binding constraint on M's contract). Then, M will impose exclusive dealing and set $q_H(\theta)^{**} = q_H{}^{ED}(\theta)$ for all $\theta \in [\theta_0, \theta_1]$. In equilibrium, R's information rents under exclusive dealing are lower than absent exclusive dealing for all $\theta \in [\theta_0, \theta_1]$.*

Proposition 4 indicates that unlike the full information case, under asymmetric information M benefits from directly imposing exclusive dealing on R. Intuitively, recall from the previous section that R's ability to sell both H and L at the same time provides R with additional benefits from understating θ. By imposing exclusive dealing M deprive R from these benefits and thereby reduces R's information rents. Moreover, compared with the optimal contract without exclusive dealing, R's information rents are lower under exclusive dealing for <u>all</u> θ, including $\theta \in [\underline{\theta}, \theta_1]$, in which R offers only H even without exclusive dealing. The intuition for this last result is that R is also privately informed about $q_H{}^C(\theta)$, which determines whether R finds it optimal to offer both H and L or only H. Thus, if M sets $q_H(\theta) > q_H{}^C(\theta)$ and thereby anticipate that R will not offer L even without imposing exclusive dealing, R can still report some $\widetilde{\theta} < \theta$, such that although $q_H(\widetilde{\theta})$

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[13] Note that in the later case the marginal information rents can be negative if $q_H(\theta) < (\gamma\theta - c_L)/2$, which implies that R's incentive to overstate θ (in order to overstate its reservation utility) dominates its incentive to understate θ. Since such countervailing incentives have been extensively analyzed by Maggi and Rodriguze-Clare (1995) and Jullien (2000), suppose that $q_H{}^{ED}(\theta) > (\gamma\theta - c_L)/2$ so that the optimal quantity under exclusive dealing is not too low as to create such countervailing incentive. Using (16), this assumption requires that $H(\theta_0) < \theta$ - $c_H - (\gamma\theta - c_L)$.

$> q_H{}^C(\tilde{\theta})$, in practice $q_H(\tilde{\theta}) < q_H{}^C(\theta)$, in which case R will sell L.[14] This potential deviation from truthful telling strategy is prevented under exclusive dealing which enables M to reduce R's information rents even for values of θ in which it sets $q_H(\theta) > q_H{}^C(\theta)$.

Next, I turn to the case in which L is efficient and thereby offered under full information:

Proposition 5: *Suppose that L is efficient.*

(i)   *If $H(\theta_0) < (c_H - c_L/\gamma)/\sqrt{1-\gamma}$, then M sets $q_H(\theta)^{**} = q_H{}^{NED}(\theta)$ and $ED(\theta) = 0$ for all $\theta \in [\theta_0,$*

   $\theta_1]$. In equilibrium, R offers both H and L for $\forall \theta \in [\theta_0, \theta_1]$.

(ii)   *If $H(\theta_0) > (c_H - c_L/\gamma)/\sqrt{1-\gamma}$, then there is a cutoff, θ^C, such that M sets*

$$q_H(\theta)^{**} = \begin{cases} q_H^{ED}(\theta), & \text{if } \theta \in [\theta_0, \theta^C], \\ q_H^{NED}(\theta), & \text{if } \theta \in [\theta^C, \theta_1], \end{cases} \quad \text{and} \quad ED(\theta)^{**} = \begin{cases} 1 & \text{if } \theta \in [\theta_0, \theta^C], \\ 0, & \text{if } \theta \in [\theta^C, \theta_1], \end{cases}$$

   In equilibrium, R offers only H if $\theta \in [\theta_0, \theta^C]$ and offers both H and L if $\theta \in [\theta^C, \theta_1]$, where θ^C is decreasing with the gap $c_H - c_L/\gamma$ and $\theta^C = \theta_1$ if $c_H - c_L/\gamma = 0$. R's information rents under exclusive dealing are lower than absent exclusive dealing for all $\theta \in [\theta_0, \theta_1]$.

(iii)   *In both cases $q_H(\theta)$ and $ED(\theta)$ satisfies IC.*

Proposition 5 shows that if asymmetric information is significant, then M may use exclusive dealing to foreclose L even though L is efficient and offered under full information. Note that exclusive dealing in the case of an efficient L is different from the inefficient L in that in the later case M will use exclusive dealing to foreclose L for all $\theta \in [\theta_0, \theta_1]$, while when L is efficient M will foreclose L only for low values of θ (except for the extreme case in which $c_H = c_L/\gamma$). Also note that $q_H(\theta)^{**}$ is not continuous at θ^C nor increasing in θ, but part (iii) reveals that $q_H(\theta)^{**}$ nonetheless satisfies *IC*.

The intuition for Proposition 5 is that if L is efficient, then exclusive dealing on one hand reduces R's information rents but on the other hand prevents R from selling an efficient quality that is profitable under full information. Part (i) of Proposition 5 indicates that if the cost of the information rents from M's viewpoint are insignificant such that $H(\theta_0)$ is low or L is highly

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[14] It is easy to see from panel (c) of Figure 1 that such deviation is possible for R. For example, for any θ $\in [\bar{\theta}, \theta_1]$, although $q_H(\theta)^{**} > q_H{}^C(\theta)$, R can nonetheless report some $\tilde{\theta} < \theta$, such that both $q_H(\tilde{\theta})^{**} \geq q_H{}^C(\tilde{\theta})$ and $q_H(\tilde{\theta})^{**} < q_H{}^C(\theta)$.

efficient such that $c_H - c_L/\gamma$ is high, then the second effect dominates and M will never impose exclusive dealing. In contrast, part (ii) indicates that in the opposite case the first effect dominates and thereby M prefers to damage the total industry profit by imposing exclusive dealing just in order to reduce R's information rents. In the later case M will impose exclusive dealing only for low values of θ, while allowing R to sell both L and H for high values of θ. This last result is somewhat surprising since R's information rents are increasing with θ which implies that M's incentive to reduce R's information rents is more significant for high (rather than low) θ. The intuition for this last result is that imposing exclusive dealing for $\theta \in [\theta_0, \theta^C]$ makes it less attractive for R to understate θ whenever θ is higher than θ^C, because by doing so R will not be able to offer L. As a result, imposing exclusive dealing for $\theta \in [\theta_0, \theta^C]$ reduces R's information rents for $\theta \in [\theta^C, \theta_1]$, although for $\theta \in [\theta^C, \theta_1]$ R is not deprived from the option to sell both L and H.

Propositions 5 along with Proposition 4 indicate that asymmetric information induces M to expand its foreclosure strategy in the sense that M impose exclusive dealing whenever L is inefficient and may impose exclusive dealing even if L is efficient and profitable under full information.

Next, I turn to analyze the effect that allowing M to use exclusive dealing have on consumers and welfare. Again I focus on the case in which asymmetric information is significant such that M imposes exclusive dealing in equilibrium.

Proposition 6: *Suppose that $H(\theta_0) > max\{(c_H - c_L/\gamma)/\sqrt{1-\gamma}$, $c_L/\gamma - c_H\}$ (M imposes exclusive dealing in equilibrium)). Then, exclusive dealing increases p_H and decreases total industry profits, consumers' surplus and thereby social welfare.*

Proposition 6 indicates that exclusive dealing as a device for reducing the retailer's information rents is not of the best interest of consumers: exclusive dealing both prevents R from offering the low quality substitute and increases the price of the high quality product. For antitrust policy, this result indicates that the somewhat tolerant approach of US courts towards exclusive dealing may not be justified under asymmetric information. However, it is important to note that exclusive dealing may still have welfare enhancing properties which are beyond the scope of this paper (as indicated in Footnote 2), thereby Proposition 6 should be interpreted as the <u>net</u> effect that asymmetric information on θ have on the market. Thus exclusive dealing should be condemned as illegal only if asymmetric information is significant enough, such that the anti-competitive

effect of exclusive dealing as indicated by Proposition 6 have the potential to offset any welfare enhancing properties.

6. Conclusion

This paper considers vertical relations when a privately informed retailer can offer a low quality substitute. From a theoretical viewpoint, this setup yields a principal-agent problem under asymmetric information, when the agent has an alternative source of payoff that it can exploit in addition to serving the principal. This raises a new informational concern for the principal, which is uninformed not only concerning the agent's potential benefits from accepting the principal offer, but also from its benefits from exploiting its second option. Moreover, the principal is ignorant on whether a given contract induces the agent to implement its second option along with the option offered by the principal.

The main result of this paper is that this second option enables the agent to extend its informational advantage and thereby increase its information rents. As such, asymmetric information induces the agent to use this second option more than under full information, and induces the principal to force the agent, if possible, to use this option less than under full information, thus reflecting the tension between the agent's incentive to increase its information rents and the principal incentive to decrease it.

These results have implications in several areas of economics. For example, in the context of a worker – employer relationship under adverse selection, the results of this paper implies that the worker can benefit from taking a second job even though this job may not be profitable under full information. In contrast, asymmetric information may induce the employer to prohibit the worker from taking a second job. In the context of regulation, one can think of a monopoly that the price of its high quality product is regulated, but the monopoly can also sell a low-quality substitute product which is not subject to regulation. If the monopoly is privately informed about its costs, then regulation may derive the monopoly to offer the low-quality product even if this product is not profitable under full information. This may force the regulator to impose restrictions not only on the price of the regulated product but also on the variety of other substitutes that the monopoly may offer. In the context of vertical relations between a manufacturer and a retailer that can sell a low quality substitute, these results provide a new explanation for why the manufacturer may impose exclusive dealing.

A somewhat restrictive assumption made throughout the paper is that L is available to R at a given exogenous cost. This assumption is suitable if L is either a private label or a low quality product sold by a perfectly competitive market. Nonetheless, I expect that some of the qualitative

results of the paper will not change if a strategic player sells L because of the following reasons. Consider first the result that asymmetric information induces R to offer L even if L is unprofitable under full information. Since this result holds when L is available to R at marginal cost, it is clear that it will also hold if L is sold by a second competing manufacturer even if this manufacturer choose to charge higher fees than just marginal cost. Moreover, note that R is strictly better off by selling L so that the manufacturer that sells L can also charge a fix fee and still gain a positive market share. Next, consider the exclusive dealing outcome of Section 5. This outcome should be robust in the case where a competing manufacturer sells L because of two reasons. First, there are no equilibria in which the competing manufacturer gains the exclusivity of R, because by assumption the profit from selling H alone is higher than the profit from selling L alone. Second, in any exclusive dealing equilibrium, L is offered at marginal cost even if a competing manufacturer sells L. Otherwise, the competing manufacturer could have lower its price and induce R to reject the exclusive contract.[15] Thus, in any exclusive dealing equilibrium with two competing manufacturers, L is available to R at marginal cost and R sells H exclusively, as in the case described at Section 5. Still a difference that can emerge by assuming that a competing manufacturer sells L is that this may give raise to multiple equilibria. Bernheim and Whinston (1998) points out that under full information, when a second manufacturer sells L, exclusive dealing equilibria may emerge even if L is profitable under vertical integration. However, they show that these equilibria are all Pareto – dominated (for both manufacturers) by the equilibrium in which R sells both H and L. Taking this into account, the assumption that L is available at a given cost enables me to rule out such dominated equilibria and focus on the more plausible outcomes.

A more crucial assumption is that R is privately informed regarding consumers' average willingness to pay, θ, and not on consumers' relative valuation of L, γ. Intuitively, if R is privately informed about γ instead of θ, then whenever R sells only H, R will have an incentive to overstate γ in order to overstate its reservation utility (R's profit form selling L exclusively). Whenever R sells H and L, then R may have a lower incentive to overstate γ because by doing so R also overstates its profit from selling L along with H. Thereby R's information rents can be lower whenever R sells both brands and M may not find it optimal to impose exclusive dealing. Notice that a similar explanation holds concerning asymmetric information on c_L (in which case R has an incentive to understate c_L, where this incentive can be lower if R sells both H and L). This implies

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[15] See Bernhiem and Whinston (1998) for a formal illustration of this point.

that asymmetric information concerning only R's profits from the alternative source may not, by itself, motivate M to impose exclusive dealing.

Appendix

Following are the proofs of Lemma 1 and Propositions 1 - 6.

Proof of Proposition 1:

The first part of Proposition 1 follows directly from maximizing (10) with respect to q_H. Next I turn to show that M will never impose exclusive dealing. If $c_L/\gamma > c_H$, exclusive dealing is redundant because R does not sell L even without exclusive dealing, and M needs to compensate R by offering R at least $\pi_L(\theta)$ even is M imposes exclusive dealing. If $c_L/\gamma < c_H$, then substituting (4) into (10), M earns $(\theta - c_H)^2/4 - (\gamma\theta - c_L)^2/4\gamma$ under exclusive dealing and $(\theta - c_H - \gamma\theta + c_L)^2/4(1-\gamma)$ otherwise, where $(\theta - c_H - \gamma\theta + c_L)^2/4(1-\gamma) - [(\theta - c_H)^2/4 - (\gamma\theta - c_L)^2/4\gamma] = \gamma(c_H - c_L/\gamma)^2/4(1 - \gamma) > 0$, implying that M will not impose exclusive dealing.

Proof of Lemma 1:

I first show that R will never report a $\widetilde{\theta}$ that mislead M into believing that R does not intend to sell L. To this end, suppose that R reports a $\widetilde{\theta}$ such that $q_H^C(\theta) > q_H(\widetilde{\theta}) > q_H^C(\widetilde{\theta})$ and thereby M charges the first line of $T(\theta)$ while R sell both H and L and earns

$$\pi_R(\widetilde{\theta};\theta) = \pi_{HL}(q_H(\widetilde{\theta});\theta) - \pi_H(q_H(\widetilde{\theta});\widetilde{\theta}) + \pi_L(\widetilde{\theta}) + \int_{\theta_0}^{\widetilde{\theta}} U'(\hat{\theta})d\hat{\theta}. \qquad \text{(A - 1)}$$

Note that since q_H^C is increasing in θ, $\widetilde{\theta} < \theta$, but the derivative of (A - 1) with respect to $\widetilde{\theta}$ is

$$\frac{\partial \pi_R(\widetilde{\theta};\theta)}{\partial\widetilde{\theta}} = (\theta(1 - \gamma) + c_L - \widetilde{\theta} + 2\gamma\, q_H(\widetilde{\theta}))q_H(\widetilde{\theta})'$$

$$\geq (\theta(1 - \gamma) + c_L - \widetilde{\theta} + 2\gamma\, q_H^C(\widetilde{\theta}))q_H(\widetilde{\theta})'$$

$$= (1 - \gamma)(\theta - \widetilde{\theta})q_H(\widetilde{\theta})'$$

$$> 0,$$

where the first inequality follows because $q_H(\widetilde{\theta}) \geq q_H^C(\widetilde{\theta})$ and $q_H(\widetilde{\theta})' \geq 0$ and the second inequality follows because $\gamma < 1$ and $\widetilde{\theta} < \theta$. Next, to show that R will not report a $\widetilde{\theta}$ that mislead M into believing that R intend to sell both H and L while in practice R will sell only H. To this end, suppose that R reports a $\widetilde{\theta}$ such that $q_H^C(\widetilde{\theta}) > q_H(\widetilde{\theta}) > q_H^C(\theta)$ and thereby M charges the second line in $T(\theta)$ and R earns

$$\pi_R(\widetilde{\theta};\theta) = \pi_H(q_H(\widetilde{\theta});\theta) - \pi_{HL}(q_H(\widetilde{\theta});\widetilde{\theta}) + \pi_L(\widetilde{\theta}) + \int_{\theta_0}^{\widetilde{\theta}} U'(\hat{\theta})d\hat{\theta}. \qquad \text{(A - 2)}$$

Note that since $q_H^C(\theta)$ is increasing in θ, $\tilde{\theta} > \theta$, but the derivative of (A - 2) with respect to $\tilde{\theta}$ is

$$\frac{\partial \pi_R(\tilde{\theta};\theta)}{\partial \tilde{\theta}} = -(\tilde{\theta}(1-\gamma) + c_L - \theta + 2\gamma q_H(\tilde{\theta}))q_H(\tilde{\theta})'$$

$$\leq -(\tilde{\theta}(1-\gamma) + c_L - \theta + 2\gamma q_H^C(\theta))q_H(\tilde{\theta})'$$

$$= -(1-\gamma)(\tilde{\theta} - \theta)q_H(\tilde{\theta})'$$

$$< 0,$$

where the first inequality follows because in the second line $q_H(\tilde{\theta}) \geq q_H^C(\theta)$ and $q_H(\tilde{\theta})' \geq 0$ and the second inequality follows because $\gamma < 1$ and $\tilde{\theta} > \theta$. Thus, it follows from (A - 1) and (A - 2) that $q_H(\theta)' > 0$ ensures that R will not mislead M on whether R intends to sell L or not. Next, suppose that M has a correct prediction that $q_H(\tilde{\theta})$ induces R to sell only H. In this case $q_H(\tilde{\theta}) > \max\{q_H^C(\theta), q_H^C(\tilde{\theta})\}$, M charges the first line of $T(\theta)$ and R earns

$$\pi_R(\tilde{\theta};\theta) = \pi_H(q_H(\tilde{\theta});\theta) - \pi_H(q_H(\tilde{\theta});\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta})d\hat{\theta}$$

The first order condition with respect to $\tilde{\theta}$ is $d\pi_R(\tilde{\theta};\theta)/d\tilde{\theta} = (\theta - \tilde{\theta})q_H(\tilde{\theta})' = 0$, hence $\tilde{\theta} = \theta$. The second order condition evaluated at $\tilde{\theta} = \theta$ is $d^2\pi_R(\tilde{\theta};\theta)/d\tilde{\theta}^2 = -q_H(\tilde{\theta})' \leq 0$ which is satisfied for $q_H(\tilde{\theta})' \geq 0$. Finally, suppose that M has a correct prediction that $q_H(\tilde{\theta})$ induces R to sell both H and L. In this case $q_H(\tilde{\theta}) < \min\{q_H^C(\theta), q_H^C(\tilde{\theta})\}$, M charges the second line of $T(\theta)$ and R earns

$$\pi_R(\tilde{\theta};\theta) = \pi_{HL}(q_H(\tilde{\theta});\theta) - \pi_{HL}(q_H(\tilde{\theta});\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta})d\hat{\theta}$$

The first order condition with respect to $\tilde{\theta}$ is $d\pi_R(\tilde{\theta};\theta)/d\tilde{\theta} = (1-\gamma)(\theta - \tilde{\theta})q_H(\tilde{\theta})' = 0$, hence $\tilde{\theta} = \theta$. The second order condition evaluated at $\tilde{\theta} = \theta$ is $d^2\pi_R(\tilde{\theta};\theta)/d\tilde{\theta}^2 = -(1-\gamma)q_H(\tilde{\theta})' \leq 0$ which is satisfied for $q_H(\tilde{\theta})' \geq 0$ since $\gamma < 1$.

Proof of Proposition 2:

The term inside the squared brackets in (15) can be written explicitly as

$$\hat{\pi}_M(q_H;\theta) = \begin{cases} \pi_{HL}(q_H;\theta) - c_H q_H - \pi_L(\theta) - H(\theta)(1-\gamma)q_H, & \text{if } q_H < q_H^C(\theta), \\ \pi_H(q_H;\theta) - c_H q_H - \pi_L(\theta) - H(\theta)\left(q_H - \frac{1}{2}(\gamma\theta - c_L)\right), & \text{if } q_H \geq q_H^C(\theta), \end{cases} \quad \text{(A - 3)}$$

which is continuous in q_H. The q_H that maximizes the first and second line in $(A-3)$ is given by the left and right hand side in (16). It is straightforward to see from (16) that if for a specific θ, $H(\theta) < c_L/\gamma - c_H$, then $q_H(\theta)^{NED} > q_H(\theta)^{ED} > q_H^C(\theta)$, and thereby for this specific θ M will set $q_H(\theta)^{**} = q_H(\theta)^{ED}$. If however for a specific θ, $c_L/\gamma - c_H < H(\theta) < (c_L/\gamma - c_H)/(1-\gamma)$ (where $c_L/\gamma - c_H < (c_L/\gamma - c_H)/(1-\gamma)$ because by assumption $c_L/\gamma - c_H > 0$ and $\gamma < 1$), then $q_H(\theta)^{NED} > q_H^C(\theta) > q_H(\theta)^{ED}$, in which case M will set for this θ: $q_H(\theta)^{**} = q_H^C(\theta)$. If $(c_L/\gamma - c_H)/(1-\gamma) < H(\theta)$, then $q_H^C(\theta) > q_H(\theta)^{NED} > q_H(\theta)^{ED}$, in which case M will set $q_H(\theta)^{**} = q_H(\theta)^{NED}$. From the definition of $H(\theta)$, it is clear that $H(\theta_0) > 0$, $H(\theta)' \leq 0$ and $H(\theta_1) = 0$. As shows in panel (a) of Figure 2, if $H(\theta_0) < c_L/\gamma - c_H$ then $H(\theta) < c_L/\gamma - c_H$ for all $\theta \in [\theta_0, \theta_1]$ which yields case (i) in Proposition 2. If $c_L/\gamma - c_H < H(\theta_0) < (c_L/\gamma - c_H)/(1-\gamma)$, then from panel (b) of Figure 2 there is a cutoff, $\overline{\theta}$, such that for $\theta \in [\theta_0, \overline{\theta}]$, $c_L/\gamma - c_H < H(\theta) < (c_L/\gamma - c_H)/(1-\gamma)$ and thereby $q_H(\theta)^{**} = q_H^C(\theta)$ while for $\theta \in [\overline{\theta}, \theta_1]$, $H(\theta) < c_L/\gamma - c_H$ and thereby $q_H(\theta)^{**} = q_H(\theta)^{ED}$, which yields case (ii). Finally, if $H(\theta_0) > (c_L/\gamma - c_H)/(1-\gamma)$, then from panel (c) of Figure 2 there is also going to be a cutoff, $\underline{\theta}$, such that for $\theta \in [\theta_0, \underline{\theta}]$, $H(\theta) > (c_L/\gamma - c_H)/(1-\gamma)$ and thereby $q_H(\theta)^{**} = q_H(\theta)^{NED}$, which yields case (iii).

Proof of proposition 3:

As in Proposition 2, M will set $q_H(\theta)$ as to maximize $(A-3)$. It is straightforward to see that if $c_H - c_L/\gamma > 0$, then $q_H^C(\theta) > q_H(\theta)^{ED} > q_H(\theta)^{NED}$, $\forall \theta \in [\theta_0, \theta_1]$. Since $(A-3)$ is continuous at $q_H^C(\theta)$, the optimal solution is $q_H(\theta)^{**} = q_H(\theta)^{NED}$, $\forall \theta \in [\theta_0, \theta_1]$, which implies that R offers both H and L for $\forall \theta \in [\theta_0, \theta_1]$.

Proof of Proposition 4:

I begin by showing that M will set $ED(\theta) = 1$ for $\forall \theta \in [\theta_0, \theta_1]$. Suppose that $H(\theta_0) > (c_L/\gamma - c_H)/(1-\gamma)$ such that $\underline{\theta} > \theta_0$. Since $c_L/\gamma - c_H > 0$, M will set $ED(\theta)$ as to maximize $\int \pi_M(ED(\theta); \theta) f(\theta) d\theta$, where for $\theta \in [\theta_0, \underline{\theta}]$, $\pi_M(ED(\theta); \theta)$ is given by

$$\pi_M(ED(\theta); \theta) = \begin{cases} \pi_{HL}(q_H^{NED}(\theta); \theta) - c_H q_H^{NED}(\theta) - \pi_L(\theta) - H(\theta)(1-\gamma) q_H^{NED}(\theta), & if\ ED(\theta) = 0, \\ \pi_H(q_H^{ED}(\theta); \theta) - c_H q_H^{ED}(\theta) - \pi_L(\theta) - H(\theta)\left(q_H^{ED}(\theta) - \frac{1}{2}(\gamma\theta - c_L)\right), & if\ ED(\theta) = 1. \end{cases}$$

Hence,

$$\pi_M(1;\theta) - \pi_M(0;\theta) = \frac{1}{4}\left(\gamma H(\theta)^2 - \frac{(c_L - \gamma c_H)^2}{(1-\gamma)\gamma}\right) > \frac{1}{4}\left(\gamma\left(\frac{c_L - \gamma c_H}{\gamma(1-\gamma)}\right)^2 - \frac{(c_L - \gamma c_H)^2}{(1-\gamma)\gamma}\right) = \left(\frac{c_L - \gamma c_H}{2(1-\gamma)}\right)^2 > 0,$$

where the first inequality follows because for $\theta \in [\theta_0, \underline{\theta}]$, $H(\theta) > (c_L/\gamma - c_H)/(1-\gamma)$. Thus M sets $ED(\theta) = 1$ for $\theta \in [\theta_0, \underline{\theta}]$. Next, for $\theta \in [\underline{\theta}, \overline{\theta}]$, $\pi_M(ED(\theta);\theta)$ is given by

$$\pi_M(ED(\theta);\theta) = \begin{cases} \pi_{HL}(q_H^C(\theta);\theta) - c_H q_H^C(\theta) - \pi_L(\theta) - (1-\gamma)(\gamma\theta - c_L)/2\gamma, & \text{if } ED(\theta) = 0, \\ \pi_H(q_H^{ED}(\theta);\theta) - c_H q_H^{ED}(\theta) - \pi_L(\theta) - H(\theta)\left(q_H^{ED}(\theta) - \frac{1}{2}(\gamma\theta - c_L)\right), & \text{if } ED(\theta) = 1. \end{cases}$$

Hence,

$$\pi_M(1;\theta) - \pi_M(0;\theta) = \frac{(c_L - \gamma c_H - \gamma H(\theta))^2}{4\gamma^2} > 0.$$

Thus for $\theta \in [\underline{\theta}, \overline{\theta}]$ M will set $ED(\theta) = 1$. Since for $\theta \in [\overline{\theta}, \theta_1]$, the optimal contract exclude L from the market, it is clear that M will set $ED(\theta) = 1$ for $\forall \theta \in [\theta_0, \theta_1]$. Note that if $c_L/\gamma - c_H < H(\theta_0) < (c_L/\gamma - c_H)/(1-\gamma)$, then the same argument holds by setting $\underline{\theta} = \theta_0$.

Next, I show that R earns lower information rents under exclusive dealing for all $\theta \in [\theta_0, \theta_1]$. Again it is sufficient to show it for $H(\theta_0) > (c_L/\gamma - c_H)/(1-\gamma)$. Substituting (16) into (13), the information rents under exclusive dealing are:

$$U(\theta)^{ED} = \frac{1}{2}\int_{\theta_0}^{\theta}\left(\hat{\theta}(1-\gamma) - H(\hat{\theta}) - c_H + c_L\right)d\hat{\theta}, \quad \forall\theta \in [\theta_0, \theta_1].$$

For $\theta \in [\theta_0, \underline{\theta}]$, the information rents absent exclusive dealing are

$$U(\theta)^{NED} = \frac{1}{2}\int_{\theta_0}^{\theta}\left((\hat{\theta} - H(\hat{\theta}))(1-\gamma) - c_H + c_L\right)d\hat{\theta}.$$

Therefore,

$$U(\theta)^{NED} - U(\theta)^{ED} = \frac{\gamma}{2}\int_{\theta_0}^{\theta}H(\hat{\theta})d\hat{\theta} > 0.$$

For $\theta \in [\underline{\theta}, \overline{\theta}]$, the information rents absent exclusive dealing are

$$U(\theta)^{NED} = \frac{1}{2}\int_{\theta_0}^{\theta}\left((\hat{\theta} - H(\hat{\theta}))(1-\gamma) - c_H + c_L\right)d\hat{\theta} + \frac{1}{2\gamma}\int_{\underline{\theta}}^{\theta}\left((\gamma\hat{\theta} - c_L)(1-\gamma)\right)d\hat{\theta}.$$

Therefore,

$$U(\theta)^{NED} - U(\theta)^{ED} = \frac{\gamma}{2} \int_{\theta_0}^{\theta} H(\hat{\theta}) d\hat{\theta} + \frac{1}{2} \int_{\underline{\theta}}^{\theta} \left(H(\hat{\theta}) + c_H - c_L / \gamma \right) d\hat{\theta} > 0,$$

where the second term is positive since for $\theta \in [\underline{\theta}, \overline{\theta}]$, $H(\theta_0) > c_L/\gamma - c_H$ (see Figure 3).

Finally, for $\theta \in [\overline{\theta}, \theta_1]$,

$$U(\theta)^{NED} = \frac{1}{2} \int_{\theta_0}^{\theta} \left((\hat{\theta} - H(\hat{\theta}))(1 - \gamma) - c_H + c_L \right) d\hat{\theta}$$

$$+ \frac{1}{2\gamma} \int_{\underline{\theta}}^{\overline{\theta}} \left((\gamma\theta - c_L)(1 - \gamma) \right) d\theta + \frac{1}{2} \int_{\overline{\theta}}^{\theta} \left(\theta(1 - \gamma) - H(\theta) - c_H + c_L \right) d\theta.$$

Therefore,

$$U(\theta)^{NED} - U(\theta)^{ED} = \frac{\gamma}{2} \int_{\theta_0}^{\theta} H(\hat{\theta}) d\hat{\theta} + \frac{1}{2} \int_{\underline{\theta}}^{\theta} \left(H(\hat{\theta}) + c_H - c_L / \gamma \right) d\hat{\theta} > 0.$$

roof of Proposition 5:

To facilitate notations, let $\tilde{q}_H^{ED} \equiv q_H^{ED}(\tilde{\theta})$ and $\tilde{q}_H^{NED} \equiv q_H^{NED}(\tilde{\theta})$. Since $c_H > c_L/\gamma$, it follows from Proposition 4 that M's profit as a function of $ED(\theta)$ is given by

$$\pi_M(ED(\theta); \theta) = \begin{cases} \pi_{HL}(q_H^{NED}; \theta) - c_H q_H^{NED} - \pi_L(\theta) - H(\theta)(1 - \gamma)q_H^{NED}, & \text{if } ED(\theta) = 0, \\ \pi_H(q_H^{ED}; \theta) - c_H q_H^{ED} - \pi_L(\theta) - H(\theta)\left(q_H^{ED} - \frac{1}{2}(\gamma\theta - c_L) \right), & \text{if } ED(\theta) = 1. \end{cases}$$

For $\forall \theta \in [\theta_0, \theta_1]$. M will set $ED(\theta) = 1$ if and only if

$$\pi_M(1; \theta) - \pi_M(0; \theta) = \frac{\gamma}{4} \left(H(\hat{\theta})^2 - \frac{(c_H - c_L / \gamma)^2}{(1 - \gamma)} \right), \tag{A - 4}$$

which is positive if and only if $H(\theta) > (c_H - c_L/\gamma)/\sqrt{1 - \gamma}$. Suppose first that $H(\theta_0) < (c_H - c_L/\gamma)/\sqrt{1 - \gamma}$. In this case $H(\theta) < H(\theta_0) < (c_H - c_L/\gamma)/\sqrt{1 - \gamma}$ for $\forall \theta \in [\theta_0, \theta_1]$, where the first inequality follows because $H(\theta)$ is decreasing with θ. Therefore $ED(\theta) = 0$ for $\forall \theta \in [\theta_0, \theta_1]$. Next, suppose that $H(\theta_0) > (c_H - c_L/\gamma)/\sqrt{1 - \gamma}$, then (A - 4) is positive at θ_0, but it is still negative at θ_1 because $H(\theta_1) = 0 < (c_H - c_L/\gamma)/\sqrt{1 - \gamma}$, where the inequality follows because $c_H - c_L/\gamma > 0$. Therefore, in this case there is a cutoff, θ^C, where $H(\theta^C) = (c_H - c_L/\gamma)/\sqrt{1 - \gamma}$, such that for $\theta \in [\theta_0,$

θ^C], $H(\theta) > c_H - c_L/\gamma)/\sqrt{1-\gamma}$ and thereby $ED(\theta) = 1$, while for $\theta \in [\theta^C, \theta_1]$, $H(\theta) < (c_H - c_L/\gamma)/\sqrt{1-\gamma}$ and thereby $ED(\theta) = 0$. Since $H(\theta^C) = (c_H - c_L/\gamma)/\sqrt{1-\gamma}$ and $H(\theta)$ is decreasing with θ, θ^C is decreasing with $c_H - c_L/\gamma$. Moreover, if $c_H - c_L/\gamma = 0$ then $H(\theta^C) = 0 = H(\theta_1)$, implying that $\theta^C = \theta_1$. To show that one can find $H(\theta_0)$ such that $\theta - c_H - (\gamma\theta - c_L) > H(\theta_0) > (c_H - c_L/\gamma)/\sqrt{1-\gamma}$, note that $\theta - c_H - (\gamma\theta - c_L)$ is increasing with θ while $(c_H - c_L/\gamma)/\sqrt{1-\gamma}$ is independent of θ. Thus $\theta - c_H - (\gamma\theta - c_L) > (c_H - c_L/\gamma)/\sqrt{1-\gamma}$ if θ is sufficiently high.

Next I turn to show that the optimal contract satisfies *IC*. In case (i), *IC* follows directly from Lemma 1 (R's profit is only the first line in $(A-1)$). Turning to case (ii), here the optimal solution violates the continuity assumption of q_H. To see that *IC* is nonetheless satisfied, suppose first that $\theta > \theta^C$. From Lemma 1 it is clear that if R chooses to report any $\tilde{\theta} > \theta^C$, then the optimal report within $\tilde{\theta} \in [\theta^C, \theta_1]$ is $\tilde{\theta} = \theta$, and R earns

$$\pi_R(\theta;\theta) = \pi_L(\theta) + \int_{\theta_0}^{\theta^C} U^{ED'}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\theta} U^{NED'}(\hat{\theta})d\hat{\theta},$$

where it follows from (13) that $U^{NED'}(\tilde{\theta}) = \tilde{q}_H^{NED}(1-\gamma)$ and $U^{ED'}(\tilde{\theta}) = \tilde{q}_H^{ED} - (\gamma\tilde{\theta} - c_L)/2$. If R reports $\tilde{\theta} < \theta^C$ then R earns:

$$\pi_R(\tilde{\theta};\theta) = \pi_H(\tilde{q}_H^{ED};\theta) - \pi_H(\tilde{q}_H^{ED};\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U^{ED'}(\hat{\theta})d\hat{\theta}$$

$$< \pi_H(q_H^{ED};\theta) - \pi_H(q_H^{ED};\theta) + \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta})d\hat{\theta}$$

$$= \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta})d\hat{\theta}$$

$$< \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\theta} \left(U^{NED'}(\hat{\theta}) - U^{ED'}(\hat{\theta})\right)d\hat{\theta}$$

$$= \pi_L(\theta) + \int_{\theta_0}^{\theta^C} U^{ED'}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\theta} U^{NED'}(\hat{\theta})d\hat{\theta}$$

$$= \pi_R(\theta;\theta),$$

where the first inequality follows from revealed preferences (using Lemma 1), the second inequality follows because $U^{NED'}(\theta) > U^{ED'}(\theta)$ and because $\theta > \theta^C$, and the last term is R's profit from reporting $\tilde{\theta} = \theta$. Thus R will not understate θ such that $\tilde{\theta} < \theta^C$. Next, suppose that $\theta < \theta^C$.

From Lemma 1 it is clear that if R chooses to report any $\widetilde{\theta} < \theta^C$, then the optimal report within $\widetilde{\theta} \in [\theta_0, \theta^C]$ is $\widetilde{\theta} = \theta$, and R earns

$$\pi_R(\theta;\theta) = \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED\,\prime}(\hat{\theta})d\hat{\theta}.$$

If R reports some $\widetilde{\theta} > \theta^C$, R buys $\widetilde{q}_H^{NED}$, offers both brand in and only if $\widetilde{q}_H^{NED} < q_H^C$, and R earns:

$$\pi_R(\widetilde{\theta};\theta) = \max\{\pi_{HL}(\widetilde{q}_H^{NED};\theta), \pi_H(\widetilde{q}_H^{NED};\theta)\} - \pi_{HL}(\widetilde{q}_H^{NED};\widetilde{\theta}) + \pi_L(\widetilde{\theta}) + \int_{\theta_0}^{\theta^C} U^{ED\,\prime}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\widetilde{\theta}} U^{NED\,\prime}(\hat{\theta})d\hat{\theta}$$

$$= \max\{\pi_{HL}(\widetilde{q}_H^{NED};\theta), \pi_H(\widetilde{q}_H^{NED};\theta)\} - \pi_{HL}(\widetilde{q}_H^{NED};\widetilde{\theta}) + \pi_L(\widetilde{\theta}) + \int_{\theta_0}^{\widetilde{\theta}} U^{NED\,\prime}(\hat{\theta})d\hat{\theta} - \int_{\theta_0}^{\theta^C} \left(U^{NED\,\prime}(\hat{\theta}) - U^{ED\,\prime}(\hat{\theta})\right)d\hat{\theta}$$

$$< \pi_{HL}(q_H^{NED};\theta) - \pi_{HL}(q_H^{NED};\theta) + \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{NED\,\prime}(\hat{\theta})d\hat{\theta} - \int_{\theta_0}^{\theta^C} \left(U^{NED\,\prime}(\hat{\theta}) - U^{ED\,\prime}(\hat{\theta})\right)d\hat{\theta}$$

$$= \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{NED\,\prime}(\hat{\theta})d\hat{\theta} - \int_{\theta_0}^{\theta^C} \left(U^{NED\,\prime}(\hat{\theta}) - U^{ED\,\prime}(\hat{\theta})\right)d\hat{\theta}$$

$$< \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED\,\prime}(\hat{\theta})d\hat{\theta}$$

$$= \pi^R(\theta;\theta),$$

where the first inequality follows from revealed preferences (using Lemma 1) and because the last term is independent of $\widetilde{\theta}$ and the second inequality follows because $U^{NED\,\prime}(\theta) > U^{ED\,\prime}(\theta)$. Thus R will not overstate θ such that $\widetilde{\theta} > \theta^C$ and *IC* is satisfied.

Proof of proposition 6:

Suppose that for a certain θ, M imposed a binding constraint of $ED(\theta) = 1$. Consider first industry profits. If for such particular θ, M sets absent the restraint $q_H^{NED}(\theta)$, then the gap in industry profits between the case of $ED(\theta) = 0$ and $ED(\theta) = 1$ is

$$\pi_{HL}(q_H^{NED}(\theta);\theta) - c_H q_H^{NED}(\theta) - (\pi_H(q_H^{ED}(\theta);\theta) - c_H q_H^{ED}(\theta)) = \frac{(\gamma c_H - c_L)^2}{4\gamma(1-\gamma)} + \frac{\gamma H(\theta)^2}{4} > 0,$$

where the inequality follows because $\gamma < 1$. If M sets absent the restraint $q_H{}^C(\theta)$ (as in the case of $c_L > \gamma c_H$ and $H(\theta_0) > (c_L - \gamma c_H)/\gamma$), then the gap in industry profits between the case of $ED(\theta) = 0$ and $ED(\theta) = 1$ is
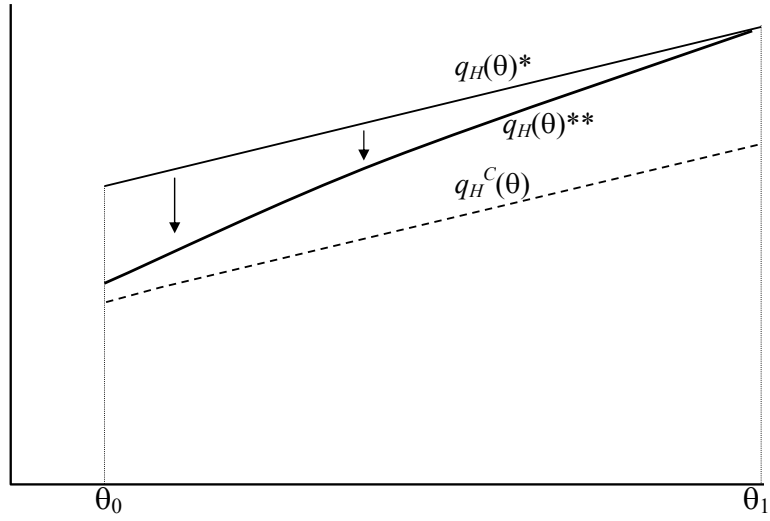
$$\pi_{HL}(q_H{}^C(\theta);\theta) - c_H q_H{}^C(\theta) - (\pi_H(q_H{}^{ED}(\theta);\theta) - c_H q_H{}^{ED}(\theta)) = \tfrac{1}{4}\left(H(\theta)^2 - \frac{(c_L - \gamma c_H)^2}{\gamma^2} \right) > 0,$$

where the inequality follows because Proposition 2 indicates that M sets $q_H{}^C(\theta)$ only for θ such that $H(\theta) > (c_L - \gamma c_H)/\gamma$. Therefore, industry profits are higher without exclusive dealing. Next consider consumers' surplus. If absent the restraint, M sets $q_H{}^{NED}(\theta)$, then the gap in the equilibrium price of H is $p_H(q_H{}^{ED}(\theta);0;\theta) - p_H(q_H{}^{NED}(\theta);q_L(q_H{}^{NED}(\theta);\theta);\theta) = (\theta + c_H + H(\theta))/2 - (\theta + c_H + H(\theta)(1 - \gamma))/2 = \gamma H(\theta)/2 > 0$. If M sets absent the restraint $q_H{}^C(\theta)$,then the gap in the equilibrium price of H is $p_H(q_H{}^{ED}(\theta);0;\theta) - p_H(q_H{}^C(\theta);0;\theta);\theta) = (\gamma H(\theta) - (c_L - \gamma c_H))/2\gamma > 0$, where the inequality follows because from Proposition 2 M sets $q_H{}^C(\theta)$ only for θ such that $H(\theta) > (c_L - \gamma c_H)/\gamma$. Since L is not offered if $ED(\theta) = 1$, it follows that both prices are lower absent exclusive dealing, implying that consumers' surplus is higher.

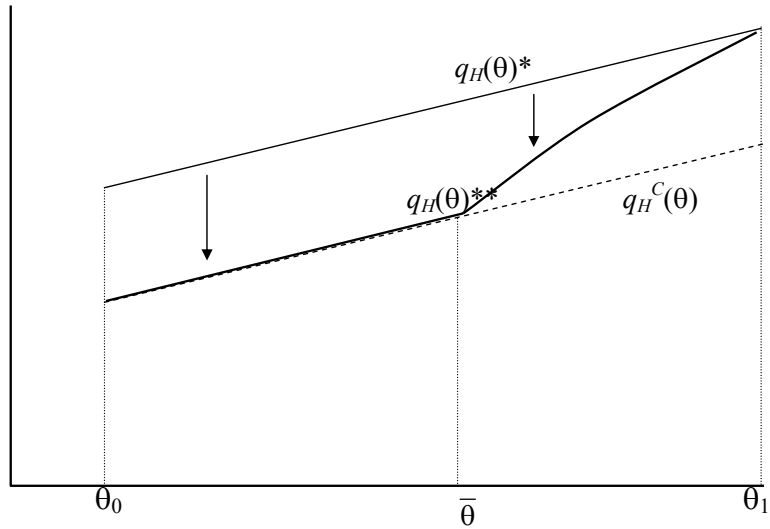**Figure 1: Optimal $q_H(\theta)$ when L is inefficient**

Panel (a):

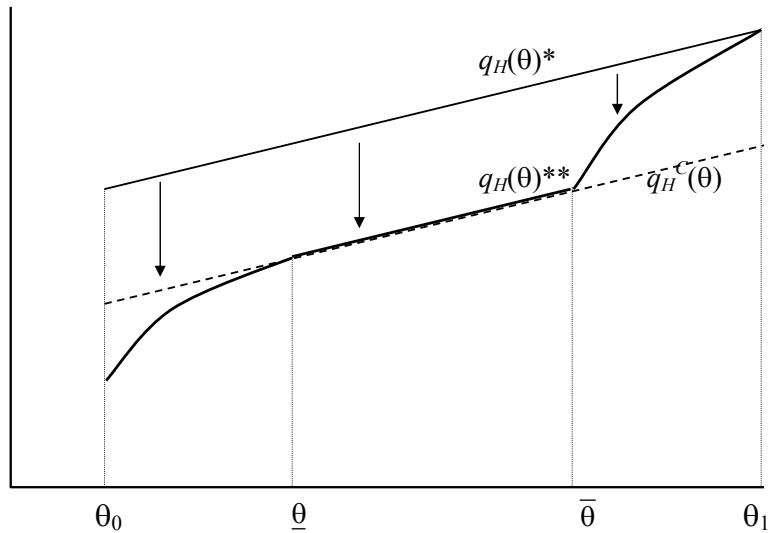$H(\theta_0) < (c_L/\gamma - c_H)$

$q_H(\theta)^*$

$q_H(\theta)^{**}$

$q_H^C(\theta)$

θ_0 θ_1

Panel (b):

$(c_L/\gamma - c_H) < H(\theta_0)$

$< (c_L/\gamma - c_H)/(1 - \gamma)$

$q_H(\theta)^*$

$q_H(\theta)^{**}$ $q_H^C(\theta)$

θ_0 $\overline{\theta}$ θ_1

Panel (c):

$(c_L/\gamma - c_H)/(1 - \gamma)$

$< H(\theta_0)$

$q_H(\theta)^*$

$q_H(\theta)^{**}$ $q_H^C(\theta)$

θ_0 $\underline{\theta}$ $\overline{\theta}$ θ_1

Figure 2: The derivation of $\underline{\theta}$ and $\bar{\theta}$.

Panel (a):

$(c_L/\gamma - c_H)/(1 - \gamma)$

$c_L/\gamma - c_H$

$H(\theta)$

θ_0 θ_1

Panel (b):

$(c_L/\gamma - c_H)/(1 - \gamma)$

$c_L/\gamma - c_H$

$H(\theta)$

θ_0 $\bar{\theta}$ θ_1

Panel (c):

$(c_L/\gamma - c_H)/(1 - \gamma)$

$c_L/\gamma - c_H$

$H(\theta)$

θ_0 $\underline{\theta}$ $\bar{\theta}$ θ_1
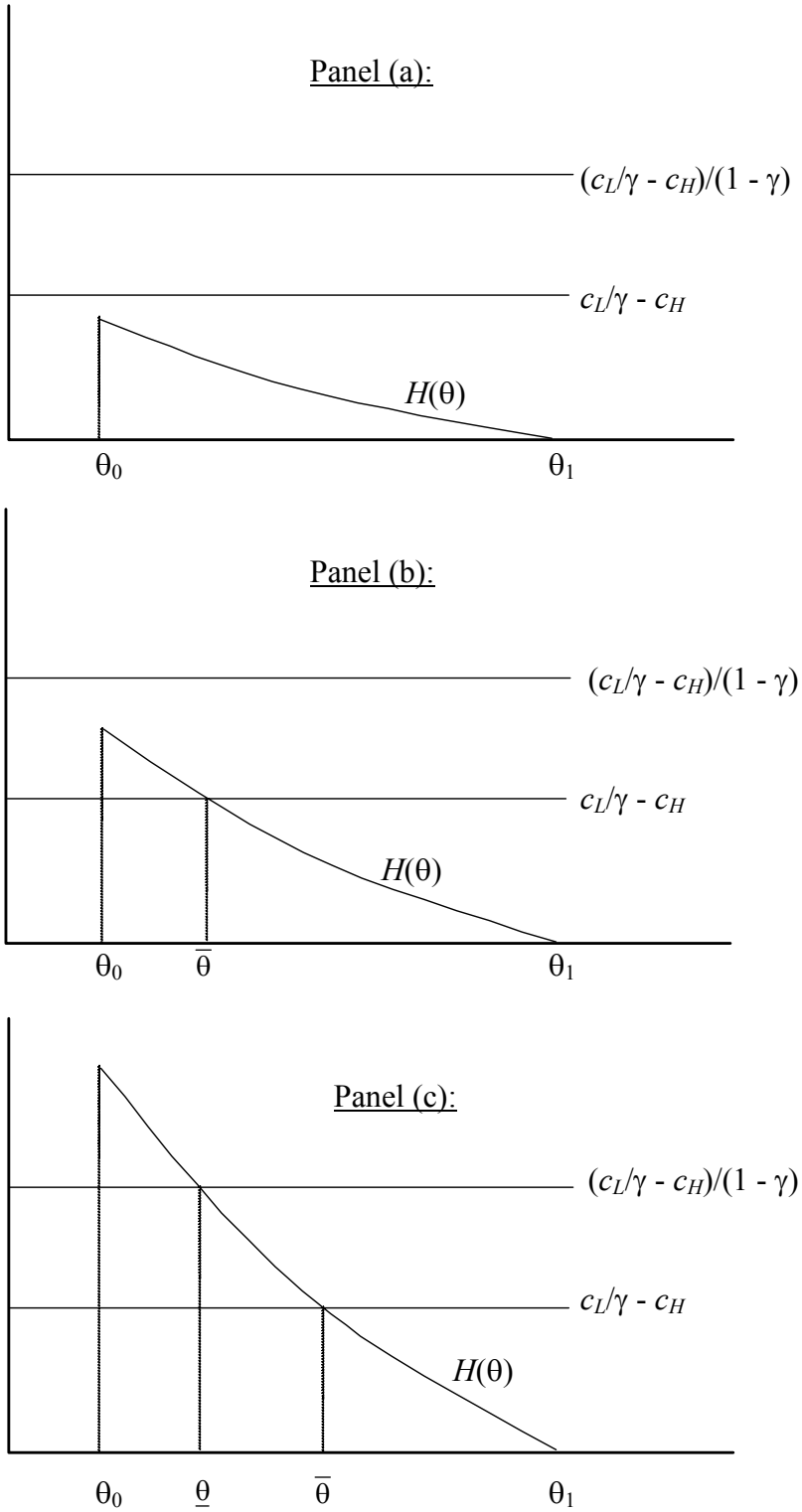
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