

# 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 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.

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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.<sup>1</sup> 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 the 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 has to impose exclusive dealing on its retailer. Exclusive dealing may enhance market performance but may also leads to exclusion of a competing brand.<sup>2</sup> Thus, US courts treat exclusive dealing under the rule of reason.<sup>3</sup>

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<sup>1</sup> 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/>.

<sup>2</sup> 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.

<sup>3</sup> 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). 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).

However, the second potential anti-competitive effect of exclusive dealing was challenged by the well-known “Chicago School” for three related reasons.<sup>4</sup> First, if offering a second brand increases the retailer’s profit, then the manufacturer 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 not profitable to begin with. Second, if for whatever reason a manufacturer wishes to foreclose a competing brand, then the manufacturer can choose between imposing exclusive dealing on the retailer, or offering him quantity discounts to induce the retailer to choose not to carry the competing brand. Either way, the manufacturer needs 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 quantity discounts that are less open to antitrust scrutiny. Third, the fact that the retailer has the option to carry the competing brand will force the manufacturer to offer discounts that the retailer is likely to pass on, at least partially, to consumers. In that sense, the competitive pressure from the competing brand holds even in the presence of exclusive dealing.

As Gilbert (2000) points out, the arguments made by the “Chicago School” parallels a more tolerant approach by US courts towards exclusive dealing.<sup>5</sup> 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.

The 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.<sup>6</sup>

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.

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<sup>4</sup> 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.”

<sup>5</sup> For example, 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.”

<sup>6</sup> 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.

Under full information, M offers a contract that induces R to sell both L and H when L is a profitable brand (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 exclusivity. The intuition for this results is that M captures R's entire added value from selling H and thereby wishes 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.

When R is privately informed about consumers' average willingness to pay, M offers R a menu of contracts that induces R to truthfully reveal its private information through its choice of contract. The model reveals that if the asymmetric information problem is significant and M is not allowed to use exclusive dealing, then R offers both L and H when L is profitable under vertical integration but will offer both H and L even if L is unprofitable. The benefit of offering L from R's viewpoint is that it makes it more attractive for R to understate its private information and thereby increases R's information rents.

This result indicates that under asymmetric information retailers will expand their product variety by offering low quality substitutes 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's decision on whether to allow R to sell L is distorted downwards. 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.

This paper relates to three areas of economic literature. First, the paper relates to Biglaiser and Mezzetti (1993), Maggi and Rodriguze-Clare (1995) and Jullien (2000) that consider mechanism design problem in which the agent has type dependent reservation utility. This problem is typically more complex because the agent is privately informed not only about its utility from accepting the principal's offer but also about the agent's reservation utility. A common assumption in these three papers is that if the agent accepts the principal's offer then the agent cannot utilize its alternative source of payoff, whereas in this paper R (the agent) can both

accept M's (the principal) contract and utilize its alternative source for payoff at the same time (by selling both L and H). Moreover, R is privately informed about its decision on whether to sell both H and L instead of just H. The model reveals that this ability imposes additional constraints on the set of truthfully revealing mechanisms which increases R's information rents even if eventually it chooses to sell only H.

Second, this paper is related to literature regarding the potential anti – competitive effects of exclusive dealing. Most previous literature 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.<sup>7</sup> Typically, such strategy is not subject to antitrust scrutiny as in the case where a dominant manufacturer prohibits its retailer from selling a competing brand, and 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 dominant manufacturer to lower its wholesale price.<sup>8</sup> O'Brien and Shaffer (1997) extend Mathewson and Winter's paper to allow for nonlinear contracts, and derive similar qualitative results to the ones obtain in this paper under full information. Namely, 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

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<sup>7</sup> 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.

<sup>8</sup> Linear contract and barriers to entry were also analyzed by Aghion and Bolton (1987). However, they assume that two competing products are homogeneous and thereby in equilibrium only one of the products is sold. Thus, exclusive dealing in their model is exogenously because an upstream firm cannot choose to accommodate its rival.

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.

The third filed of research that relates to this paper is on the economic benefits of providing private labels. Two related papers are Mills (1995 and 1999) that analyze the introduction of private label in the context of a vertical differentiation model. My model differs from Mills's in that Mills considers only linear pricing under full information and focus solely on a private label which is not profitable under vertical integration. He shows that a retailer will offer private label in order to mitigate the well-known double marginalization problem. Moreover, he finds that a retailer is more likely to produce a private label if consumers have a high average willingness to pay for quality. In contrast, this paper shows that unprofitable private label is offered only if consumers have on average a low (rather than high) willingness to pay for quality.

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) who produces a high quality product (H) at marginal cost  $c_H$ . M does not have the capability 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 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 the 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

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

where  $\gamma$  ( $0 < \gamma < 1$ ) measures the relative quality of L from the consumers' viewpoint (while the quality of H is normalized to 1). Alternatively,  $\gamma$  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  $2 + c_H \geq \theta \geq 1$ . Thus  $\theta$  measures the consumers' average willingness to pay for quality. The restrictions on  $\theta$  ensures 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 though will prefer to buy H. As I will show later on, this assumption rules out the uninteresting case in which H is never offered.

As is well known (see Spiegel and Yehezkel (2003)), in order to sell both L and H,  $p_L$  should be sufficiently lower than  $p_H$  in the sense that  $p_H > p_L/\gamma$ , in which case high type consumers with  $v \geq (p_H - p_L)/(1 - \gamma)$  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. Thus, in order to sell both products, the downstream firm should set the following prices:<sup>9</sup>

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

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  $v > p_H$  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  $v > p_L/\gamma$  buy L and the inverse demand function is  $p_L(q_L, 0; \theta) = \gamma(\theta - q_L)$ .

Under vertical integration, a jointly owned firm, M–R, decides on both quantities of H and L in order to maximize the sum of industry profits, given by

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<sup>9</sup> Throughout this model, there is going to be a monopoly in the downstream market and thereby considering a price setting firm yields identical results as a quantity setting firm. However I assume that R maximizes its profit with respect to quantities and then replace the optimal quantities into (2) in order to establish the prices that induce consumers to buy these optimal quantities. Assuming a quantity setting firm facilitates the analysis and enables me to directly present the conditions for offering positive quantity of both L and H.

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

Following Spiegel and Yehezkel (2003), the vertical integration quantities are

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

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  $c_L < \gamma c_H$ , or alternatively  $\gamma/c_L > 1/c_H$ . Moreover, it is straightforward to show that although the quantities that maximizes total welfare are higher than (4), still a social planner that maximizes total welfare will offer L if and only if  $c_L < \gamma c_H$ . Intuitively, L is *efficient* only if its cost-adjusted quality,  $\gamma/c_L$ , is higher than the cost adjusted-quality of H,  $1/c_H$  (where recall that the quality of H is normalized to 1). Otherwise, L is *inefficient* and a vertically integrated monopoly (or a social planner) will not offer it. 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 from R to M, and R can either accept or reject the offer. In stage 2, if R accepted M's offer then R chooses the optimal quantities of H and L. If R rejects M's offer, R offers only L to final consumers.

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 set  $q_L$  as to maximize

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

Hence,

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

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 with selling only H. Substituting (6) back into (5), R's indirect profit from accepting M's contract is

$$\pi^R(q_H; \theta) = \begin{cases} \pi_{HL}(q_H; \theta) - T(\theta), & \text{if } q_H < q_H^C(\theta), \\ \pi_H(q_H; \theta) - T(\theta), & \text{if } q_H \geq q_H^C(\theta). \end{cases} \quad (7)$$

where

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

$$\pi_H(q_H; \theta) = p_H(0, q_H; \theta)q_H. \quad (9)$$

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

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

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. Maximizing (10) obtains the following Proposition:

**Proposition 1:** *Under full information, M sets  $\{q_H, T\} = \{q_H(\theta)^*, \pi(\theta)^* + c_H q_H(\theta)^* - \pi_L(\theta)\}$  and R sets the vertical integration quantities. In equilibrium, R earns  $\pi_L(\theta)$  and M earns  $\pi(\theta)^* - \pi_L(\theta)$ .*

Proposition 1 shows that although M can always induce R to sell only H (by setting  $q_H > q_H^C(\theta)$ ), M will do so only if L is inefficient and thereby unprofitable under vertical integration. Otherwise, the optimal contract induces R to offer both H and L. The intuition for this result 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 profit and will use  $T$  to capture all of R's added gross profit from selling H regardless of whether L is efficient or not.

This result indicates 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.

Furthermore, Proposition 1 implies that under full information, 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 will have to leave R with its reservation utility,  $\pi_L(\theta)$ , regardless of whether R sells L or not, thus exclusive dealing does not provide M with any additional advantage over the nonlinear contract. This result indicates 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.

#### 4. 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. 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  $\theta$  and that  $\theta$  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.

Suppose that due to antitrust laws, M cannot impose exclusive dealing on R, and thus M is restricted to nonlinear contract. In order to induce R to truthfully reveal its private information, M offers a menu,  $\{q_H(\theta), T(\theta)\}$ , and R reports  $\tilde{\theta}$  and receives the corresponding pair  $(q_H(\tilde{\theta}), T(\tilde{\theta}))$  from the menu (whenever necessary, I will denote R's report as  $\tilde{\theta}$  in order to distinguish R's report from the true  $\theta$ ). Since exclusive dealing is prohibited, M's contract design problem should take into account two important features. First, as in the full information case M needs to enable R to earn at least its reservation utility which is R's profit from selling L exclusively. However, R is privately informed about its reservation utility because its profit from selling L exclusively depends on  $\theta$ . Thus, M faces a mechanism design problem when the agent has type dependent reservation utility. Second, given a report  $\tilde{\theta}$ , M is uninformed not only regarding R's potential profit from selling  $q_H(\tilde{\theta})$ , but also regarding the potential profit that R can obtain by selling L. Moreover, unlike the full information case, under asymmetric information M does not know whether a given  $q_H(\tilde{\theta})$  induces R to offer L and if so, what is the expected quantity,  $q_L(q_H(\tilde{\theta}); \theta)$ , which depends on the actual  $\theta$ . Thus the mechanism design problem should also account for the possibility that the agent, R, can both accept the contract and utilize its alternative source of payoff at the same time.

Due to this second feature, I consider a contract design problem that accounts for the possibility that R offers 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. It is natural to suspect (and indeed this will turn out as the outcome of this section) that in equilibrium, there is going to be at most one sub-interval of  $[\theta_0, \theta_1]$  in which R offers both H and L. However, I do not impose this restriction upfront so the contract design allows for more than one such sub-interval.

Given that R can offer both H and L, it is clear from Section 3 that if R accepts a contract and reports some  $\tilde{\theta}$ , R will sell  $q_L(q_H(\tilde{\theta});\theta) > 0$  if  $q_H(\tilde{\theta}) < q_H^C(\theta)$  and will sell only H if  $q_H(\tilde{\theta}) > q_H^C(\theta)$  where  $q_L(q_H;\theta)$  and  $q_H^C(\theta)$  are given by (6). Hence, M's problem when M cannot impose exclusive dealing is

$$\max_{\{T(\tilde{\theta}), q_H(\tilde{\theta})\}} \int_{\theta_0}^{\theta_1} (T(\theta) - c_H q_H(\theta)) f(\theta) d(\theta), \quad (11)$$

s.t.  $\forall \theta, \tilde{\theta} \in [\theta_0, \theta_1]$ :

$$(IR_1) \quad \pi_H(q_H(\theta); \theta) - T(\theta) \geq \pi_L(\theta), \quad \text{if } q_H^C(\theta) \leq q_H(\theta),$$

$$(IR_2) \quad \pi_{HL}(q_H(\theta); \theta) - T(\theta) \geq \pi_L(\theta), \quad \text{if } q_H^C(\theta) > q_H(\theta),$$

$$(IC_1) \quad \pi_H(q_H(\theta); \theta) - T(\theta) \geq \pi_H(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}), \quad \text{if } q_H^C(\theta) < q_H(\theta) \text{ and } q_H^C(\theta) < q_H(\tilde{\theta}),$$

$$(IC_2) \quad \pi_{HL}(q_H(\theta); \theta) - T(\theta) \geq \pi_{HL}(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}), \quad \text{if } q_H^C(\theta) > q_H(\theta) \text{ and } q_H^C(\theta) > q_H(\tilde{\theta}),$$

$$(IC_3) \quad \pi_{HL}(q_H(\theta); \theta) - T(\theta) \geq \pi_H(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}), \quad \text{if } q_H^C(\theta) > q_H(\theta) \text{ and } q_H^C(\theta) < q_H(\tilde{\theta}),$$

$$(IC_4) \quad \pi_H(q_H(\theta); \theta) - T(\theta) \geq \pi_{HL}(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}), \quad \text{if } q_H^C(\theta) < q_H(\theta) \text{ and } q_H^C(\theta) > q_H(\tilde{\theta}).$$

The difference between this problem and the usual contract design problem under asymmetric information is in the IC constraints. Here there are four types of IC constraints that cover R's four potential deviations from truth-telling strategy.  $IC_1$  ensures that given that  $q_H(\theta)$  induces R not to offer L, R will not report  $\tilde{\theta} \neq \theta$  such that  $q_H(\tilde{\theta})$  still induces R not to offer L.  $IC_2$  ensures that given that R is expected to offer both L and H (in the sense that  $q_H(\theta) < q_H^C(\theta)$ ), R will not report  $\tilde{\theta} \neq \theta$  such that  $q_H(\tilde{\theta})$  still induces R to offer both L and H.  $IC_3$  and  $IC_4$  are necessary because given R's report,  $\tilde{\theta}$ , M only knows  $q_H^C(\tilde{\theta})$  while R's decision to sell both H and L is determined according to the real  $\theta$  through  $q_H^C(\theta)$ .  $IC_3$  ensures that given that R is expected to offer both H and L, R will not report some  $\tilde{\theta}$  that induces R to offer only H.  $IC_3$  also covers the possibility that R will report some  $\tilde{\theta}$  such that  $q_H(\tilde{\theta}) < q_H^C(\tilde{\theta})$  and thereby M determines  $T(\tilde{\theta})$  under the assumption that R offers both L and H while in practice  $q_H(\tilde{\theta}) > q_H^C(\theta)$  and R offers only H. The reversed strategy is prevented by  $IC_4$ , that indicates that if  $\theta$  and  $q_H(\theta)$  are such that R is not expected to offer L (as  $q_H(\theta) > q_H^C(\theta)$ ), R will not report some  $\tilde{\theta}$  such that  $q_H(\tilde{\theta}) < q_H^C(\theta)$  and

offer both L and H. This restriction covers that possibility that R will report some  $\tilde{\theta}$  such that  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$ , and thereby mislead M into believing that R does not intend to offer both qualities (and M will determined  $T(\tilde{\theta})$  according to this belief), while in practice  $q_H(\tilde{\theta}) < q_H^C(\tilde{\theta})$  which means that R eventually offers both qualities.

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 the agent can choose whether to benefit from its alternative source of utility along with the utility that it can obtain from accepting the contract (as specified by IC). Let

$$U(\tilde{\theta}; \theta) = \begin{cases} \pi_H(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}) - \pi_L(\theta), & \text{if } q_H(\tilde{\theta}) \geq q_H^C(\theta), \\ \pi_{HL}(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}) - \pi_L(\theta), & \text{if } q_H(\tilde{\theta}) < q_H^C(\theta), \end{cases} \quad (12)$$

and let  $U(\theta; \theta) \equiv U(\theta)$  denote the information rents. Since there are potential sub-intervals of  $[\theta_0, \theta_1]$  in which R offers both H and L while in other intervals R offers only H, I provide necessary and sufficient conditions for only local IC within each specific such interval (that is, conditions that ensures that R will not report any  $\tilde{\theta} \neq \theta$  where both  $\tilde{\theta}$  and  $\theta$  belongs to the same sub-interval). After establishing the optimal solution to (11), I will show that this solution also satisfies global IC in the sense that R will not misreport  $\theta$  between different intervals.

**Lemma 1:** *Consider a sub-interval  $[\theta', \theta''] \in [\theta_0, \theta_1]$  and suppose that  $q_H(\theta)$  is twice differentiable within  $[\theta', \theta'']$ . Then, necessary and sufficient conditions for IR and for local IC at  $\theta, \tilde{\theta} \in [\theta', \theta'']$ , are  $U(\theta_0) = 0, q_H(\theta)' \geq 0$ , and*

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

Note that within each sub-interval,  $[\theta', \theta''] \in [\theta_0, \theta_1]$ , R has an incentive to understate  $\theta$  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  $\theta$  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  $U'(\theta) > 0$ . 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  $\theta_0$  and thereby there are no countervailing incentives in equilibrium. Using Lemma 1 and the definition of  $U(\theta)$ , M will set

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

Substituting (14) into (11) and rearranging, M's problem is

$$\text{Max}_{q_H(\theta)} \int_{\theta_0}^{\theta_1} [\pi^M(q_H(\theta); \theta) - H(\theta)U'(\theta)] f(\theta) d\theta, \quad (15)$$

where  $\pi^M(q_H(\theta); \theta)$  is given by (10). 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

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

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  $\theta$ . Then,*

- (i) *If  $H(\theta_0) < (c_L - \gamma c_H) / \gamma$ , then M offers  $q_H(\theta)^{**} = q_H(\theta)^{ED}$  and R offers only H for  $\forall \theta \in [\theta_0, \theta_1]$ .*
- (ii) *If  $(c_L - \gamma c_H) / \gamma < H(\theta_0) < (c_L - \gamma c_H) / \gamma(1 - \gamma)$ , then there is a cutoff,  $\bar{\theta}$ , where  $H(\bar{\theta}) = (c_L - \gamma c_H) / \gamma$ , such that M offers:*

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

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

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

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

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  $\gamma$  and  $c_H$  and decreasing with  $c_L$ .

In all three cases  $q_H(\theta)^{**}$  satisfies global IC.

Part (i) of Proposition 2 indicates that since L is inefficient and not offered under full information, asymmetric information will not change this if other things being equal, asymmetric information is not significant enough (in the sense that  $H(\theta_0)$  is low). Likewise, R will not offer both qualities even under asymmetric information if for a given  $H(\theta_0)$ , L is extremely inefficient in the sense that the gap between the cost-adjusted qualities of H and L,  $1/c_H - \gamma/c_L$ , is sufficiently high.

However, part (iii) of Proposition 2 shows that if the asymmetric information problem is significant enough or L is not too inefficient, then the equilibrium contract induces R to offer both qualities whenever  $\theta \in [\theta_0, \underline{\theta}]$ . This sub-interval in which both qualities are offered becomes wider as  $H(\theta_0)$  is higher or the gap  $1/c_H - \gamma/c_L$  is smaller. In the extreme case in which  $1/c_H - \gamma/c_L = 0$  (such that under full information R is just indifferent between offering both qualities or only H), then  $\bar{\theta} = \underline{\theta} = \theta_1$  and thereby R offers both qualities for all  $\theta \in [\theta_0, \theta_1]$ .

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  $\theta$  and thereby reduces R's information rents. If  $H(\theta_0)$  is low, then from part (i), the downwards distortion is modest such that  $q_H^{ED}(\theta)$  is still higher than  $q_H^C(\theta)$  for all  $\theta$ , and R offers only H, as shown in Panel (a) of Figure 1. For high values of  $H(\theta_0)$ ,  $q_H^{ED}(\theta)$  falls below  $q_H^C(\theta)$ , which induces R to sell both H and L. This raises a new problem for M, because whenever R sells both L and H, R can understate  $\theta$  and thereby mislead M not only regarding the revenues from H, but also regarding the quantity of L that R sells,  $q_L(q_H(\tilde{\theta}); \theta)$ . More precisely, if R reports some  $\tilde{\theta} < \theta$ , then M believes that for a given quantity of H,  $q_H(\tilde{\theta})$ , R sells  $q_L(q_H(\tilde{\theta}); \tilde{\theta}) = (\gamma \tilde{\theta} - c_L) / 2\gamma - q_H(\tilde{\theta})$  and thereby M will charge  $T(\tilde{\theta})$  accordingly. However, in practice R will sell  $q_L(q_H(\tilde{\theta}); \theta)$

$= (\gamma\theta - c_L)/2\gamma - q_H(\tilde{\theta}) > (\gamma\tilde{\theta} - c_L)/2\gamma - q_H(\tilde{\theta}) = q_L(q_H(\tilde{\theta}); \tilde{\theta})$  (because  $\theta > \tilde{\theta}$ ) and earn additional profits. Thus, by distorting  $q_H(\theta)$  downwards and below  $q_H^C(\theta)$ , M on one reduces R's information rents because quantity is lower, but on the other hand 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  $\theta$ . Then, M offers  $q_H(\theta)^{**} = q_H(\theta)^{NED}$  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 wishes 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 fact that under asymmetric information  $q_H(\theta)$  is distorted downwards only increases the incentive to sell both L and H and thereby both qualities are offered for all  $\theta \in [\theta_0, \theta_1]$ .

Proposition 3 along with parts (ii) and (iii) of Proposition 2 indicates that asymmetric information induces R to “oversell” 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 whenever they are profitable under vertical integration and may also be offered otherwise when asymmetric information is significant and when consumers' willingness to pay falls below manufacturers' expectations as in the case of economic depression (since M expect that  $\theta \in [\theta_0, \theta_1]$ , L will be offered if the actual realization of  $\theta$  is on the lower part of M's expectations). 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 in turn 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 if the asymmetric information problem is significant, then 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.

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  $\theta$  and  $ED(\theta) = 0$  otherwise. Note that by allowing  $ED(\theta)$  to depend on  $\theta$ , exclusive dealing is type-dependent in that in equilibrium, M may include an exclusive dealing clause for some values of  $\theta$  and allow R to sell H and L for others.

M's problem is identical to (11), except that now  $IR_2$  and  $IC_3$  holds only if  $ED(\theta) = 0$ ,  $IC_4$  holds only if  $ED(\tilde{\theta}) = 0$  and  $IC_2$  holds only if both  $ED(\theta) = 0$  and  $ED(\tilde{\theta}) = 0$ . Intuitively, exclusive dealing relaxes the constraints on M's problem because if R reports a certain  $\tilde{\theta}$  such that  $ED(\tilde{\theta}) = 1$ , then R cannot sell both qualities even if  $q_H(\tilde{\theta}) < q_H^C(\theta)$ .

Building on Lemma 1, it is clear that if for a sub-interval  $[\theta', \theta''] \in [\theta_0, \theta_1]$  M sets  $ED(\theta) = 0$ , then the marginal information rents for  $\theta \in [\theta', \theta'']$  are given by (13), and local IC holds for  $\theta, \tilde{\theta} \in [\theta', \theta'']$  if  $q_H(\theta)' \geq 0$  for  $\theta \in [\theta', \theta'']$ . Likewise, if for a sub-interval  $[\theta', \theta''] \in [\theta_0, \theta_1]$  M sets  $ED(\theta) = 1$ , then the marginal information rents for  $\theta \in [\theta', \theta'']$  are given by the first line in (13), which holds for both  $q_H(\theta) \leq q_H^C(\theta)$  and  $q_H(\theta) > q_H^C(\theta)$ , and again local IC holds for  $\theta, \tilde{\theta} \in [\theta', \theta'']$  if  $q_H(\theta)' \geq 0$  for  $\theta \in [\theta', \theta'']$ . 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  $\theta$  (in order to overstate its reservation utility) dominates its incentive to understate  $\theta$ . 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.<sup>10</sup>

Using (13), M's problem is to set  $q_H(\theta)$  and  $ED(\theta)$  as to maximize (15), where  $\pi^M(q_H(\theta); \theta)$  is given by (10) and the first line in (10) requires both  $q_H(\theta) < q_H^C(\theta)$  and  $ED(\theta) = 0$  while the second line in (10) holds for either  $q_H(\theta) > q_H^C(\theta)$  or  $ED(\theta) = 1$ .

<sup>10</sup> Using (16), this assumption requires that  $H(\theta_0) < \theta - c_H - (\gamma\theta - c_L)$ .

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  $(c_L - \gamma c_H)/\gamma < H(\theta_0)$  (absent exclusive dealing, L impose a binding constraint on M's contract). Then, M will impose exclusive dealing for all  $\theta \in [\theta_0, \theta_1]$  and set  $q_H(\theta)^{**} = q_H(\theta)^{ED}$ . 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, because exclusive dealing reduces R's information rents. Moreover, compared with the optimal contract without exclusive dealing, R's information rents are lower under exclusive dealing for all  $\theta$ , including  $\theta \in [\underline{\theta}, \theta_1]$ , in which R offers only H even without exclusive dealing. The intuition for this last result comes from the fact 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  $\tilde{\theta} < \theta$ , such that although  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$ , in practice  $q_H(\tilde{\theta}) < q_H^C(\theta)$ , in which case R will sell L.<sup>11</sup> 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  $\theta$  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. Then,*

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

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<sup>11</sup> It is easy to see from panel (c) of Figure 1 that such deviation is possible for R. For example, for any  $\theta \in [\tilde{\theta}, \theta_1]$ , 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  $q_H(\tilde{\theta})^{**} < q_H^C(\theta)$ .

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

*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  $\theta^C$  is decreasing with the gap  $\gamma c_H - c_L$  and  $\theta^C = \theta_1$  if  $\gamma c_H - c_L = 0$ . R's profit under exclusive dealing is lower than absent exclusive dealing for all  $\theta \in [\theta_0, \theta_1]$ .*

*In both cases  $q_H(\theta)$  and  $ED(\theta)$  satisfies global 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 is 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  $\theta$  (except for the extreme case in which  $\gamma c_H = c_L$ ).

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 asymmetric information is insignificant such that  $H(\theta)$  is low, then the second effect dominates and M will never impose exclusive dealing. In contrast, part (ii) indicates that if asymmetric information is significant then the first effect dominates and thereby M prefer 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  $\theta$ , while allowing R to sell both L and H for high values of  $\theta$ . This last result is somewhat surprising since R's information rents are increasing with  $\theta$  which implies that M's incentive to reduce R's information rents is more significant for high (rather than low)  $\theta$ . 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  $\theta$  whenever  $\theta$  is higher than  $\theta^C$ , 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 distort its foreclosure strategy upwards 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 vertical integration.

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

Proposition 6 indicates that in the context of asymmetric information, an upstream manufacturer may impose exclusive dealing even though it reduces the joint profit of the vertical structure and although the manufacturer can use nonlinear contract. Moreover, exclusive dealing as a device for reducing the retailer's information rents is not of the best interest of consumers. For antitrust policy, this result indicates that the somewhat tolerant approach of US courts towards exclusive dealing may not be justified under asymmetric information. It is important to note that exclusive dealing may have welfare enhancing properties which are beyond the scope of this paper (as indicated in Footnote 4), thereby Proposition 6 should be interpreted as the net effect that asymmetric information have on the market. This implies that 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.

In the context of vertical relations between an upstream manufacturer and a downstream retailer, these results provide an explanation for why a retailer may offer private labels or other low-quality substitute, and show that in the presence of asymmetric information private labels may emerge even if their cost adjusted quality is poor such that these products are not profitable under vertical integration. Moreover, these results illustrate that exclusive dealing can play an active role in eliminating a competing brand from the market, even if such brands have high cost adjusted quality and are profitable under vertical integration.

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 vertical integration. 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, it is clear that there are no equilibria in which the competing manufacturer gains the exclusivity of R. This is because by assumption the profit from selling H alone is higher than the profit from selling L alone. Second, it is clear that 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.<sup>12</sup> 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, 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

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<sup>12</sup> See Bernhiem and Whinston (1998) for a formal illustration of this point.

available at a given cost enables me to rule out such dominated equilibria and focus on the more plausible outcomes.

As a final remark, the results of this paper are derived within the specific framework of vertical relations, but they may also have implications in other areas of economics in which an agent have type dependent reservation utility that it can enjoy in addition to accepting the principal contract. For example, in the context of a worker – employer relationship under moral hazard, 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 add to the working contract a clause that prohibits the worker from taking a second job. In the context of regulation, one can think of a monopoly that the price of its main high quality product is regulated, but the monopoly can 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.

## Appendix

Following are the proofs of Lemma 1 and Propositions 2 - 6.

### Proof of Lemma 1:

Equation (13) is derived by differentiating (12) and using the envelope theorem. To show that  $U(\theta_0) > 0$  is sufficient for IR, note that  $U'(\theta) > 0$  for  $\forall \theta \in [\theta_0, \theta_1]$ , where in the first line in (13),  $U'(\theta) > 0$  follows because  $q_H(\theta) > q_H^C(\theta) > (\gamma\theta - c_L)/2$  and in the second and third line  $U'(\theta) > 0$  follows because by assumption  $1 > \gamma$  and  $\gamma\theta > c_L$ . Thus  $U(\theta_0) = 0$  implies  $U(\theta) = 0$  for  $\forall \theta \in [\theta_0, \theta_1]$  which satisfies IR. Next, to show that  $q_H(\theta)' > 0$  is a sufficient condition for local IC, consider  $[\theta', \theta''] \in [\theta_0, \theta_1]$  such that  $\theta \in [\theta', \theta'']$  and  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$ ,  $\forall \tilde{\theta} \in [\theta', \theta'']$ . From (14), R's profit is

$$\pi^R(\tilde{\theta}; \theta) = \begin{cases} \pi_H(q_H(\tilde{\theta}); \theta) - \pi_H(q_H(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta}) d\hat{\theta}, & \text{if } q_H(\tilde{\theta}) \geq q_H^C(\theta), \\ \pi_{HL}(q_H(\tilde{\theta}); \theta) - \pi_H(q_H(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta}) d\hat{\theta}, & \text{if } q_H(\tilde{\theta}) < q_H^C(\theta), \end{cases} \quad (\text{A - 1})$$

where it is straightforward to see that (A - 1) is continuous at  $q_H(\tilde{\theta}) = q_H^C(\theta)$  and since  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$ ,  $\forall \tilde{\theta} \in [\theta', \theta'']$ ,  $U'(\tilde{\theta}) = q_H(\tilde{\theta}) - (\gamma\tilde{\theta} - c_L)/2$ ,  $\forall \tilde{\theta} \in [\theta', \theta'']$ . Note that the second part of (A - 1) is possible even though  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$ ,  $\forall \tilde{\theta} \in [\theta', \theta'']$ , because both  $q_H(\theta)$  and  $q_H^C(\theta)$  are increasing with  $\theta$ . I first show that the solution to (A - 1) can never be in the second line. To this end, note that since by assumption  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$  for  $\tilde{\theta} \in [\theta', \theta'']$  and since  $q_H^C(\theta)$  is increasing with  $\theta$ ,  $q_H(\tilde{\theta}) < q_H^C(\theta)$  requires reporting  $\tilde{\theta} < \theta$ . However, differentiating the second line in (A - 1) with respect to  $\tilde{\theta}$  yields:

$$\begin{aligned} \frac{\partial \pi^R(\tilde{\theta}; \theta)}{\partial \tilde{\theta}} &= (\theta(1-\gamma) + c_L - \tilde{\theta} + 2\gamma q_H(\tilde{\theta})) q_H'(\tilde{\theta}) \\ &> (\theta(1-\gamma) + c_L - \tilde{\theta} + 2\gamma q_H^C(\tilde{\theta})) q_H'(\tilde{\theta}) \\ &= (1-\gamma)(\theta - \tilde{\theta}) q_H'(\tilde{\theta}) \\ &> 0, \end{aligned}$$

where the first inequality follows because by assumption  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta})$  and  $q_H'(\tilde{\theta}) \geq 0$  and the second inequality follows because  $\gamma < 1$  and  $\tilde{\theta} < \theta$ . Therefore R will never set  $\tilde{\theta} < \theta$  such that

$q_H(\tilde{\theta}) < q_H^C(\theta)$ . Next, suppose that R chooses  $\tilde{\theta}$  such that  $q_H(\tilde{\theta}) \geq q_H^C(\theta)$ . Differentiating the first line with respect to  $\tilde{\theta}$  yields  $d\pi^R(\tilde{\theta};\theta)/d\tilde{\theta} = (\theta - \tilde{\theta})q_H'(\tilde{\theta}) = 0$ , and hence,  $\tilde{\theta} = \theta$ . The second order condition evaluated at  $\tilde{\theta} = \theta$  is  $d^2\pi^R(\tilde{\theta};\theta)/d\tilde{\theta}^2 = -q_H'(\theta) \leq 0$  which is satisfied for  $q_H'(\theta) \geq 0$ .

Next suppose that  $\theta, \in [\theta', \theta'']$  and  $q_H(\tilde{\theta}) = q_H^C(\tilde{\theta}), \forall \tilde{\theta} \in [\theta', \theta'']$ . From (14), R's profit is

$$\pi^R(\tilde{\theta};\theta) = \begin{cases} \pi_H(q_H^C(\tilde{\theta});\theta) - \pi_H(q_H^C(\tilde{\theta});\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta})d\hat{\theta}, & \text{if } \tilde{\theta} \geq \theta, \\ \pi_{HL}(q_H^C(\tilde{\theta});\theta) - \pi_H(q_H^C(\tilde{\theta});\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta})d\hat{\theta}, & \text{if } \tilde{\theta} < \theta, \end{cases} \quad (\text{A - 2})$$

where it is straightforward to see that (A - 2) is continuous at  $\tilde{\theta} = \theta$  and since  $q_H(\tilde{\theta}) > q_H^C(\tilde{\theta}), \forall \tilde{\theta} \in [\theta', \theta'']$ ,  $U'(\tilde{\theta}) = (1 - \gamma)(\gamma\tilde{\theta} - c_L)/2\gamma, \forall \tilde{\theta} \in [\theta', \theta'']$ . Differentiating (A - 2) yields:

$$\frac{\partial \pi^R(\tilde{\theta};\theta)}{\partial \tilde{\theta}} = \begin{cases} \frac{1}{2}(\theta - \tilde{\theta}), & \text{if } \tilde{\theta} \geq \theta, \\ \frac{1}{2}(1 - \gamma)(\theta - \tilde{\theta}), & \text{if } \tilde{\theta} < \theta. \end{cases} \quad (\text{A - 3})$$

Hence,  $\tilde{\theta} = \theta$ .

Finally, suppose that for all  $\theta, \in [\theta', \theta'']$  and  $q_H(\tilde{\theta}) < q_H^C(\tilde{\theta}), \forall \tilde{\theta} \in [\theta', \theta'']$ . From (14), R's profit is

$$\pi^R(\tilde{\theta};\theta) = \begin{cases} \pi_{HL}(q_H(\tilde{\theta});\theta) - \pi_{HL}(q_H(\tilde{\theta});\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta})d\hat{\theta}, & \text{if } q_H(\tilde{\theta}) < q_H^C(\theta), \\ \pi_H(q_H(\tilde{\theta});\theta) - \pi_{HL}(q_H(\tilde{\theta});\tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U'(\hat{\theta})d\hat{\theta}, & \text{if } q_H(\tilde{\theta}) \geq q_H^C(\theta), \end{cases} \quad (\text{A - 4})$$

where (A - 4) is continuous at  $q_H(\tilde{\theta}) = q_H^C(\theta)$  and  $U'(\tilde{\theta}) = q_H(\tilde{\theta})(1 - \gamma), \forall \tilde{\theta} \in [\theta', \theta'']$ . I first show that the solution to (A - 4) can never be in the second line. To this end, note that since by assumption  $q_H(\tilde{\theta}) < q_H^C(\tilde{\theta})$  for  $\tilde{\theta} \in [\theta', \theta'']$  and since  $q_H^C(\theta)$  is increasing with  $\theta$ ,  $q_H(\tilde{\theta}) \geq q_H^C(\theta)$  requires reporting  $\tilde{\theta} > \theta$ . However, differentiating the second line in (A - 4) with respect to  $\tilde{\theta}$  yields

$$\begin{aligned}
\frac{\partial \pi^R(\tilde{\theta}; \theta)}{\partial \tilde{\theta}} &= -(\tilde{\theta}(1-\gamma) + c_L - \theta + 2\gamma q_H(\tilde{\theta}))q_H'(\tilde{\theta}) \\
&< -(\tilde{\theta}(1-\gamma) + c_L - \theta + 2\gamma q_H^C(\theta))q_H'(\tilde{\theta}) \\
&= -(1-\gamma)(\tilde{\theta} - \theta)q_H'(\tilde{\theta}) \\
&< 0,
\end{aligned}$$

where the first inequality follows because in the second line  $q_H(\tilde{\theta}) > q_H^C(\theta)$  and  $q_H'(\tilde{\theta}) \geq 0$  and the second inequality follows because  $\gamma < 1$  and  $\tilde{\theta} > \theta$ . Therefore R will never set  $\tilde{\theta} > \theta$  such that  $q_H(\tilde{\theta}) \geq q_H^C(\theta)$ . Next, suppose that R chooses  $\tilde{\theta}$  such that  $q_H(\tilde{\theta}) < q_H^C(\theta)$ . Differentiating the first line with respect to  $\tilde{\theta}$  yields  $d\pi^R(\tilde{\theta}; \theta)/d\tilde{\theta} = (1-\gamma)(\theta - \tilde{\theta})q_H'(\tilde{\theta}) = 0$ , and hence,  $\tilde{\theta} = \theta$ . The second order condition evaluated at  $\tilde{\theta} = \theta$  is  $d^2\pi^R(\tilde{\theta}; \theta)/d\tilde{\theta}^2 = -(1-\gamma)q_H'(\theta) \leq 0$  which is satisfied for  $q_H'(\theta) \geq 0$  since  $\gamma < 1$ .

In all three cases IR are satisfied since  $U(\theta_0) = 0$  and  $U(\theta)' > 0$ .

### Proof of Proposition 2:

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

$$\hat{\pi}^M(q_H; \theta) = \begin{cases} \pi_{HL}(q_H; \theta) - c_H q_H - \pi_L(\theta) - H(\theta)(1-\gamma)q_H, & \text{if } q_H < q_H^C(\theta), \\ \pi_H(q_H; \theta) - c_H q_H - \pi_L(\theta) - H(\theta)(q_H - \frac{1}{2}(\gamma\theta - c_L)), & \text{if } q_H \geq q_H^C(\theta), \end{cases} \quad (\text{A} - 5)$$

which is continuous in  $q_H$ . It is straightforward to see from (16) that if for a specific  $\theta$ ,  $H(\theta) < (c_L - \gamma c_H)/\gamma$ , then  $q_H(\theta)^{NED} > q_H(\theta)^{ED} > q_H^C(\theta)$ , and thereby for this specific  $\theta$  M will set  $q_H(\theta)^{**} = q_H(\theta)^{ED}$ . If however for a specific  $\theta$ ,  $(c_L - \gamma c_H)/\gamma < H(\theta) < (c_L - \gamma c_H)/\gamma(1-\gamma)$  (where  $(c_L - \gamma c_H)/\gamma < (c_L - \gamma c_H)/\gamma(1-\gamma)$  because by assumption  $c_L - \gamma c_H$  and  $\gamma < 1$ ), then  $q_H(\theta)^{NED} > q_H^C(\theta) > q_H(\theta)^{ED}$ , in which case M will set for this  $\theta$ :  $q_H(\theta)^{**} = q_H^C(\theta)$ . If  $(c_L - \gamma c_H)/\gamma(1-\gamma) < H(\theta)$ , 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  $H(\theta_0) < (c_L - \gamma c_H)/\gamma$  then  $H(\theta) < (c_L - \gamma c_H)/\gamma$  for all  $\theta \in [\theta_0, \theta_1]$  which yields case (i) in Proposition 2. If  $(c_L - \gamma c_H)/\gamma < H(\theta_0) < (c_L - \gamma c_H)/\gamma(1-\gamma)$ , then from panel (b) of Figure 2 there is a cutoff,  $\bar{\theta}$ , such that for  $\theta \in [\theta_0, \bar{\theta}]$ ,  $(c_L - \gamma c_H)/\gamma < H(\theta) < (c_L - \gamma c_H)/\gamma(1-\gamma)$  and thereby  $q_H(\theta)^{**} = q_H^C(\theta)$  while for  $\theta \in [\bar{\theta}, \theta_1]$ ,  $H(\theta) < (c_L - \gamma c_H)/\gamma$  and thereby  $q_H(\theta)^{**} = q_H(\theta)^{ED}$ , which yields case (ii). Finally, if

$H(\theta_0) > (c_L - \gamma c_H) / \gamma(1 - \gamma)$ , then from panel (c) of Figure 2 there is also going to be a cutoff,  $\underline{\theta}$ , such that for  $\theta \in [\theta_0, \underline{\theta}]$ ,  $H(\theta) > (c_L - \gamma c_H) / \gamma(1 - \gamma)$  and thereby  $q_H(\theta)^{**} = q_H(\theta)^{NED}$ , which yields case (iii).

Next I turn to show that IC holds for all  $\theta \in [\theta_0, \theta_1]$ . Here it is sufficient to consider case (iii) which is a generalize case of (i) and (ii). First note that  $q_H(\theta)$  is continues. From (14) it is clear that  $T(\theta)$  is also continues. Suppose first that  $\theta \in [\theta_0, \underline{\theta}]$ . To see that R will not report any  $\tilde{\theta} \in [\underline{\theta}, \bar{\theta}]$ :

(A - 6)

$$\pi_{HL}(q_H(\theta); \theta) - T(\theta) > \pi_{HL}(q_H(\underline{\theta}); \theta) - T(\underline{\theta}) = \pi_H(q_H(\underline{\theta}); \theta) - T(\underline{\theta}) > \pi_H(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}),$$

where the first inequality follows from revealed preferences and Lemma 1, the proceeding equality follows because  $\{q_H(\theta), T(\theta)\}$  is continues and the last inequality follows from revealed preferences and Lemma 1. Next I show that R will not report any  $\tilde{\theta} \in [\bar{\theta}, \theta_1]$ ,

$$\pi_{HL}(q_H(\theta); \theta) - T(\theta) > \pi_H(q_H(\bar{\theta}); \theta) - T(\bar{\theta}) > \pi_H(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}),$$

(A - 7)

where the first inequality follows from (A - 6) and the last inequality follows from revealed preferences and Lemma 1.

Now suppose that  $\theta \in [\underline{\theta}, \bar{\theta}]$ . To see that R will not report any  $\tilde{\theta} \in [\theta_0, \underline{\theta}]$ :

$$\pi_H(q_H(\theta); \theta) - T(\theta) > \pi_{HL}(q_H(\underline{\theta}); \theta) - T(\underline{\theta}) > \pi_{HL}(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}),$$

(A - 8)

where the two inequalities follows from revealed preferences and Lemma 1. To see that R will not report any  $\tilde{\theta} \in [\bar{\theta}, \theta_1]$ :

$$\pi_H(q_H(\theta); \theta) - T(\theta) > \pi_H(q_H(\bar{\theta}); \theta) - T(\bar{\theta}) > \pi_H(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}),$$

(A - 9)

where the first and the second inequalities follows revealed preferences and Lemma 1 respectively.

Finally, suppose that  $\theta \in [\bar{\theta}, \theta_1]$ . To see that R will not report any  $\tilde{\theta} \in [\underline{\theta}, \bar{\theta}]$ :

$$\pi_H(q_H(\theta); \theta) - T(\theta) > \pi_{HL}(q_H(\bar{\theta}); \theta) - T(\bar{\theta}) > \pi_{HL}(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}),$$

(A - 10)

where the first and the second inequalities follows from revealed preferences and Lemma 1. To see that R will not report any  $\tilde{\theta} \in [\theta_0, \underline{\theta}]$ :

$$\pi_H(q_H(\theta); \theta) - T(\theta) > \pi_{HL}(q_H(\underline{\theta}); \theta) - T(\underline{\theta}) > \pi_{HL}(q_H(\tilde{\theta}); \theta) - T(\tilde{\theta}), \quad (\text{A - 11})$$

where the first inequality follows from (A - 10) and the last inequality follows from revealed preferences and Lemma 1.

### Proof of proposition 3:

As in Proposition 2, M will set  $q_H(\theta)$  as to maximize (A - 5). It is straightforward to see that if  $\gamma c_H > c_L$ , then  $q_H^C(\theta) > q_H(\theta)^{ED} > q_H(\theta)^{NED}$ ,  $\forall \theta \in [\theta_0, \theta_1]$ . Since (A - 5) 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  $\forall \theta \in [\theta_0, \theta_1]$ . Moreover, global IC is ensured from Lemma 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  $H(\theta_0) > (c_L - \gamma c_H)/\gamma(1 - \gamma)$  such that  $\underline{\theta} > \theta_0$ . Since  $L$   $c_L > \gamma c_H$ , 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

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

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  $\theta \in [\theta_0, \underline{\theta}]$ ,  $H(\theta) > (c_L - \gamma c_H)/\gamma(1 - \gamma)$ . Thus M sets  $ED(\theta) = 1$  for  $\theta \in [\theta_0, \underline{\theta}]$ . Next, for  $\theta \in [\underline{\theta}, \bar{\theta}]$ ,  $\pi^M(ED(\theta); \theta)$  is given by

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

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  $\theta \in [\underline{\theta}, \bar{\theta}]$  M will set  $ED(\theta) = 1$ . Since for  $\theta \in [\bar{\theta}, \theta_1]$ , 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  $(c_L - \gamma c_H)/\gamma(1 - \gamma) < H(\theta_0) < (c_L - \gamma c_H)/\gamma$ , then the same argument holds by setting  $\underline{\theta} = \theta_0$ .

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

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

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

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

Therefore,

$$U(\theta)^{NED} - U(\theta)^{ED} = \frac{1}{2} \int_{\theta_0}^{\theta} (\gamma H(\theta)) d\theta > 0.$$

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

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

Therefore,

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

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

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

$$\begin{aligned}
U(\theta)^{NED} &= \frac{1}{2} \int_{\theta_0}^{\theta} ((\theta - H(\theta))(1-\gamma) - c_H + c_L) d\theta \\
&\quad + \frac{1}{2\gamma} \int_{\frac{\theta}{\gamma}}^{\frac{\theta}{\gamma}} ((\gamma\theta - c_L)(1-\gamma)) d\theta + \frac{1}{2} \int_{\frac{\theta}{\gamma}}^{\theta} (\theta(1-\gamma) - H(\theta) - c_H + c_L) d\theta.
\end{aligned}$$

Therefore,

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

### Proof of Proposition 5:

Since  $\gamma c_H > c_L$ , it follows from Proposition 4 that M's profit as a function of  $ED(\theta)$  is given by

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

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

$$\pi^M(1; \theta) - \pi^M(0; \theta) = \frac{1}{4} \left( \gamma H(\theta)^2 - \frac{(\gamma c_H - c_L)^2}{(1-\gamma)\gamma} \right) \quad (\text{A - 12})$$

which is positive if and only if  $H(\theta) > (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ . Suppose first that  $H(\theta_0) < (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ . In this case  $H(\theta) < H(\theta_0) < (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ , where the first inequality follows because  $H(\theta)$  is decreasing with  $\theta$ . Therefore  $ED(\theta) = 0$  for  $\forall \theta \in [\theta_0, \theta_1]$ . Next, suppose that  $H(\theta_0) > (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ , then (A - 12) is positive at  $\theta_0$ , but it is still negative at  $\theta_1$  because  $H(\theta_1) = 0 < (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ , where the inequality follows because  $\gamma c_H > c_L$ . Therefore, in which case there is a cutoff,  $\theta^C$ , where  $H(\theta^C) = (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ , such that for  $\theta \in [\theta_0, \theta^C]$ ,  $H(\theta) > (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$  and thereby  $ED(\theta) = 1$ , while for  $\theta \in [\theta^C, \theta_1]$ ,  $H(\theta) < (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$  and thereby  $ED(\theta) = 0$ . Since  $H(\theta^C) = (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$  and  $H(\theta)$  is decreasing with  $\theta$ ,  $\theta^C$  is decreasing with  $(\gamma c_H - c_L)$ . Moreover, if  $(\gamma c_H - c_L) = 0$  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  $\theta - c_H - (\gamma\theta - c_L) > H(\theta_0) > (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$ , note that  $\theta - c_H - (\gamma\theta -$

$c_L$ ) is increasing with  $\theta$  while  $(\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$  is independent of  $\theta$ . Thus  $\theta - c_H - (\gamma\theta - c_L) > (\gamma c_H - c_L)/\gamma\sqrt{1-\gamma}$  if  $\theta$  is sufficiently high.

Next I turn to show that the optimal contract satisfies global IC. In case (i), global IC follows directly from Lemma 1 (see (A - 4)). Turning to case (ii), it follows from Lemma 1 that IC is satisfied locally for  $\theta, \tilde{\theta} \in [\theta_0, \theta^C]$  and for  $\theta, \tilde{\theta} \in [\theta^C, \theta_1]$ , so it is left to show that if  $\theta < \theta^C$  ( $> \theta^C$ ), then R will not report any  $\tilde{\theta} > \theta^C$  ( $< \theta^C$ ). Given that R will not report any other  $\tilde{\theta} \neq \theta$  such that  $\theta, \tilde{\theta} \in [\theta_0, \theta^C]$  (and likewise for  $\theta, \tilde{\theta} \in [\theta^C, \theta_1]$ ), R's profit is:

$$\pi^R(\tilde{\theta}; \theta) = \begin{cases} \pi_H(q_H^{ED}(\tilde{\theta}); \theta) - \pi_H(q_H^{ED}(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U^{ED'}(\hat{\theta})d\hat{\theta}, & \text{if } \tilde{\theta} < \theta^C, \\ \pi_{HL}(q_H^{NED}(\tilde{\theta}); \theta) - \pi_{HL}(q_H^{NED}(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\theta^C} U^{ED'}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\tilde{\theta}} U^{NED'}(\hat{\theta})d\hat{\theta}, & \text{if } \tilde{\theta} \geq \theta^C. \end{cases}$$

where  $U^{NED'}(\tilde{\theta}) = q_H^{NED}(\tilde{\theta})(1 - \gamma)$  and  $U^{ED'}(\tilde{\theta}) = q_H^{ED}(\tilde{\theta}) - (\gamma\tilde{\theta} - c_L)/2$ . Suppose first that  $\theta > \theta^C$ . If R reports  $\tilde{\theta} < \theta^C$  then R earns:

$$\begin{aligned} \pi^R(\tilde{\theta}; \theta) &= \pi_H(q_H^{ED}(\tilde{\theta}); \theta) - \pi_H(q_H^{ED}(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U^{ED'}(\hat{\theta})d\hat{\theta} \\ &< \pi_H(q_H^{ED}(\theta); \theta) - \pi_H(q_H^{ED}(\theta); \theta) + \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta})d\hat{\theta} \\ &= \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta})d\hat{\theta} \\ &< \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\theta} (U^{NED'}(\hat{\theta}) - U^{ED'}(\hat{\theta}))d\hat{\theta} \\ &= \pi_L(\theta) + \int_{\theta_0}^{\theta^C} U^{ED'}(\hat{\theta})d\hat{\theta} + \int_{\theta^C}^{\theta} U^{NED'}(\hat{\theta})d\hat{\theta} \\ &= \pi^R(\theta; \theta), \end{aligned}$$

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  $\theta$  such that  $\tilde{\theta} < \theta^C$ . Next, suppose that  $\theta < \theta^C$  and that R reports some  $\tilde{\theta} > \theta^C$ . R earns in this case:

$$\begin{aligned}
\pi^R(\tilde{\theta}; \theta) &= \pi_{HL}(q_H^{NED}(\tilde{\theta}); \theta) - \pi_{HL}(q_H^{NED}(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\theta^C} U^{ED'}(\hat{\theta}) d\hat{\theta} + \int_{\theta^C}^{\tilde{\theta}} U^{NED'}(\hat{\theta}) d\hat{\theta} \\
&= \pi_{HL}(q_H^{NED}(\tilde{\theta}); \theta) - \pi_{HL}(q_H^{NED}(\tilde{\theta}); \tilde{\theta}) + \pi_L(\tilde{\theta}) + \int_{\theta_0}^{\tilde{\theta}} U^{NED'}(\hat{\theta}) d\hat{\theta} - \int_{\theta_0}^{\theta^C} (U^{NED'}(\hat{\theta}) - U^{ED'}(\hat{\theta})) d\hat{\theta} \\
&< \pi_{HL}(q_H^{NED}(\theta); \theta) - \pi_{HL}(q_H^{NED}(\theta); \theta) + \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{NED'}(\hat{\theta}) d\hat{\theta} - \int_{\theta_0}^{\theta^C} (U^{NED'}(\hat{\theta}) - U^{ED'}(\hat{\theta})) d\hat{\theta} \\
&= \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{NED'}(\hat{\theta}) d\hat{\theta} - \int_{\theta_0}^{\theta^C} (U^{NED'}(\hat{\theta}) - U^{ED'}(\hat{\theta})) d\hat{\theta} \\
&< \pi_L(\theta) + \int_{\theta_0}^{\theta} U^{ED'}(\hat{\theta}) d\hat{\theta} \\
&= \pi^R(\theta; \theta),
\end{aligned}$$

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

### Proof of proposition 6:

Suppose that for a certain  $\theta$ , M imposed a binding constraint of  $ED(\theta) = 1$ . Consider first industry profits. If for such particular  $\theta$ , 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

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

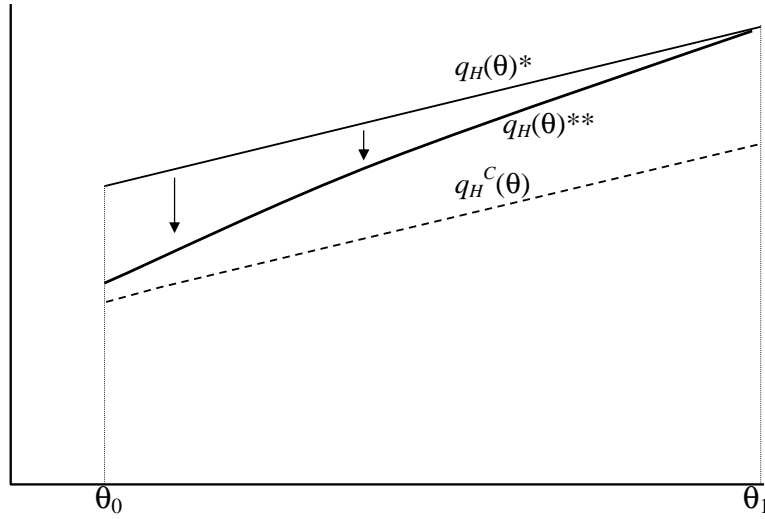
where the inequality follows because Proposition 2 indicates that M sets  $q_H^C(\theta)$  only for  $\theta$  such that  $H(\theta) > (c_L - \gamma c_H)/\gamma$ . Therefore, industry profits are higher without exclusive dealing. Next consider consumers' surplus. If absent the restraint, M sets  $q_H^{NED}(\theta)$ , 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  $p_H(q_H^{ED}(\theta); 0; \theta) - p_H(q_H^C(\theta); 0; \theta) = (\gamma H(\theta) - (c_L - \gamma c_H))/2\gamma > 0$ , where

the inequality follows because from Proposition 2 M sets  $q_H^C(\theta)$  only for  $\theta$  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):**

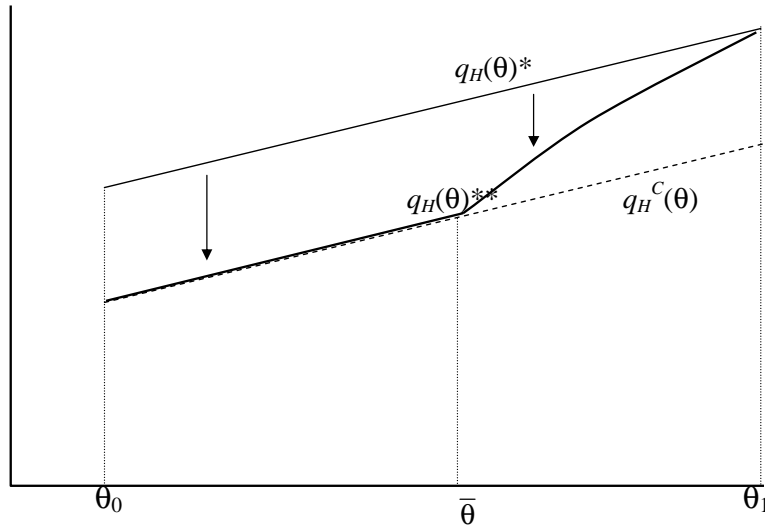
$$H(\theta_0) < (c_L - \gamma c_H) / \gamma$$



**Panel (b):**

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

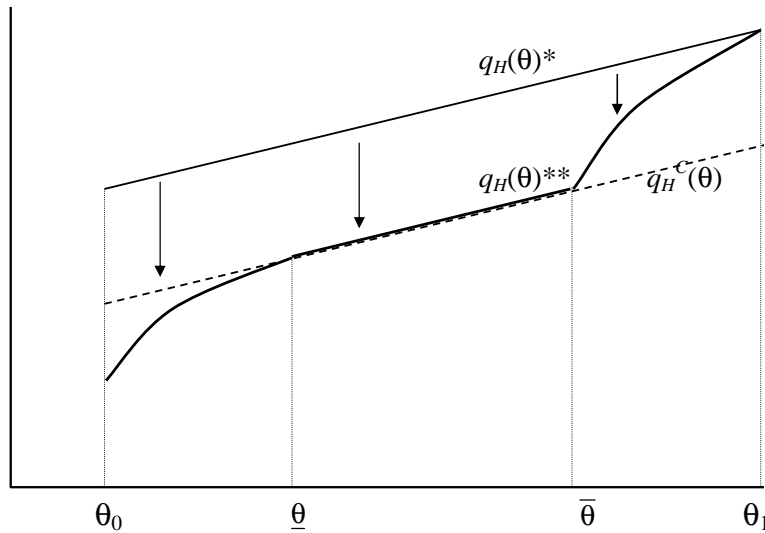
$$< (c_L - \gamma c_H) / \gamma(1 - \gamma)$$



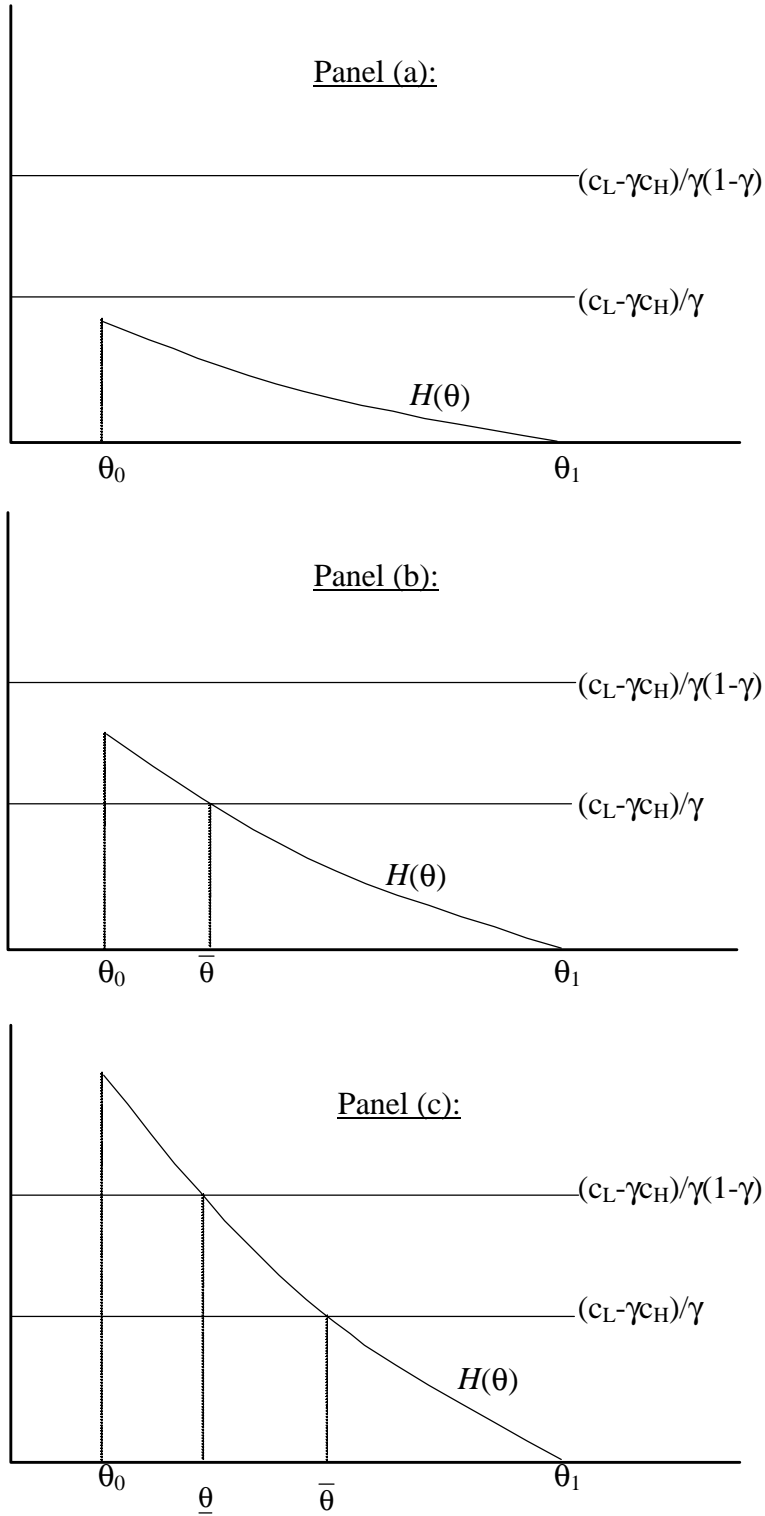
**Panel (c):**

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

$$< H(\theta_0)$$



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



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