

## **When Should Firms Reveal their Bestsellers?**

Ajay Kalra and Sameer Mathur<sup>1</sup>

February 19, 2008

---

<sup>1</sup> Ajay Kalra (e-mail: [kalra@andrew.cmu.edu](mailto:kalra@andrew.cmu.edu); Phone: 412 268 2270, Fax: 412 268 7357) is an Associate Professor of Marketing and Sameer Mathur (<http://www.smathur.com>, [smathur@andrew.cmu.edu](mailto:smathur@andrew.cmu.edu), Phone: 412 657 0257, Fax 412 268 7357) is a doctoral candidate at the Tepper School of Business, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA 15213. The order of authorship is alphabetical.

## **When Should Firms Reveal their Bestsellers?**

### **Abstract**

Some manufactures and retailers reveal which products are their bestselling items while others elect not to. We examine the conditions under which it is more profitable for a firm to reveal their bestsellers. The effect of the announcement is that customer' perceptions of their match with the bestselling product increase. This effect leads to shift in consumer preferences and impacts the prices that the firm charges. We investigate when either the high price or low priced product is the bestseller. We show that the decision to reveal the bestseller depends on the extent of heterogeneity in consumers' valuation for quality, the heterogeneity in consumers' taste preferences and the quality difference between the two products. We find that consumers must be relatively highly heterogeneous either in valuation for quality or in taste preferences but not in both. We experimentally test the assumption that bestseller announcements change consumer preferences and also find empirical evidence that firms' pricing behavior is linked to their strategy of announcing bestsellers. We also show that posting the bestsellers reduces consumer welfare.

Key Words: Bestsellers, Firm Announcement, Product Differentiation

Consider a consumer purchasing a new bed who is uncertain about which combination of attributes (e.g., thickness, softness) best matches her requirements. The web site of the Comfort Beds, who directly sell the Sleep Number Bed to consumers, informs customers that within their product line, the model Sleep Number 5000 is their most popular model. Similarly, manufacturers such as Hewlett Packard and Sephora also reveal their bestsellers. On the other hand, manufacturers like Dell, Tempur-Pedic and Mary Kay do not announce their best selling items. Even retailers differ in whether they reveal their bestsellers to consumers. For example, the merchandiser stores Costco, Best Buy, Circuit City and Footlocker make bestseller information available to consumers but Sam's Club, Zappos.com, Joann Fabrics and Gap elect not to do so.

Informing consumers what the bestselling products are is not new. The first bestseller list appeared for the books category in 1895 in a magazine titled *The Bookman* (Miller 2000). Subsequently, several magazines and newspapers have established their own lists. In contrast to the book bestseller lists that are constructed and revealed by independent sources, the decision to announce bestsellers by manufacturers and retailers appears to be a strategic one. As the anecdotal evidence indicates, it is puzzling that some manufacturers and retailers have adopted the approach of proclaiming their best selling products while others have not.

Announcing the bestselling products serves the objective of disclosing the revealed preferences of other consumers. The revelation in turn, likely influences the decision making of consumers who have not fully formed their preferences. There is a rich literature that other people's opinions influence evaluations particularly when perception of perceived risk increase or if there is a high level of uncertainty or cognitive effort required in decision making (Dowling and Staelin 1994). The literature on diffusion, conspicuous consumption (e.g., Amaldoss and

Jain 2005) and on social networks (e.g., Shi et al 2006) indicates that consumers are influenced by decisions of other consumers. In a review of the herding literature, Bikchandani et al (1998) discuss the importance of how individuals learn from actions of others.

The empirical evidence on the effect of bestseller information on demand is limited. Sorensen (2004) examines the impact of sales of books after they appear in the *New York Times* list. He finds that, on average, sales increase by 13-14% by being on the bestseller list. The most benefit is accrued by first-time authors, whose average sales increase by 57%, while the best known authors benefit the least.

As compared to other marketing mix instruments, announcing bestsellers is a relatively costless mechanism to shift demand in a specific direction. The objective of this paper is to examine whether it is more profitable for a firm to announce their best selling product. In our framework, the firm knows its own bestsellers which could be either its high quality-high price product or it could be the low quality-low priced product. The firm faces a decision of whether to disclose this information to consumers. We delineate the conditions under which the firm should reveal their bestsellers and conditions when it should not. We study how the decision depends on the extent of heterogeneity in consumers' valuation for quality, the heterogeneity in consumers' taste preferences and the quality differences between the products. We also investigate the impact of promulgating bestsellers on consumer welfare.

### ***Overview of the Model and Key Results***

We develop a monopoly framework where a firm sells two products. As in other models (e.g., Desai 2001, Tyagi 2004), the products are both vertically and horizontally differentiated. The vertical differentiation reflects that one product has “more is better” type of features such as a digital camera's zoom and size of the screen display. Here, the benefits of the “more is better”

types of attributes are clearly discernable to consumers (e.g., Desai 2001, Desai et al 2001). Therefore, one product is higher quality and priced higher than the other one. Consumers are heterogeneous in their valuation for quality where some consumers are willing to pay a higher price for any given quality level than other consumers.

Consumers' taste preferences also differ and this is captured by their location in a linear market (Hotelling 1929). The location of the consumer indicates their ideal point. The transportation cost of any given consumer indicates their degree of mismatch between his/her ideal point and any of the two products available in the market. The products are also horizontally differentiated. The horizontal differentiation reflects features where more is not necessarily better, such as design, features and form. We depart from papers in the literature which interpret transportation costs to reflect the extent of horizontal differentiation. Instead, we endogenize the length of the Hotelling line with a larger length implying a higher level of horizontal differentiation. For example, consider a first manufacturer who sells two mattresses with 9" and 12" thickness versus a second manufacturer who sells 6" and 14" thickness. We consider the second manufacturer to offer more horizontally differentiated products than the first one.

Consumer's decision on whether to purchase a product and which one to buy is a function of the positive utility derived from the quality level of the product, the disutility incurred from their transportation costs and the price of the products.

Based on the past sales history, the firm privately knows the bestselling item and has to make a decision on whether to announce it. The effect of the announcement is that the widespread approval of the product decreases consumers' uncertainty about the bestseller. In other words, their perception of their match or fit with the bestseller increases.

In modeling terms, consumers' transportation costs with respect to the best selling product decrease while their transportation costs with respect to the non-bestselling item increase. The bestseller revelation decreases consumers' disutility of purchasing the bestseller and increases the disutility of buying the non-bestseller.

Another force driving the results is that after the bestseller announcement, the firm can take advantage of the shifting preferences by increasing the price of the bestselling product and lowering the price of the non-bestselling item. These price changes impact the consumers' buy/no buy decision and also whether to switch from purchasing one product to the other.

We analyze the conditions under which the firm should reveal that the low quality-low price product is the bestseller and when it should reveal the high quality-high price to be the bestseller. The factors that impact the decision are the extent of heterogeneity in consumers' valuation for quality, the heterogeneity in consumers' taste preferences and the quality difference between the two products.

An interesting finding is that when there is more heterogeneity in consumers' taste preferences, firms should reveal the bestseller only if it is the high-quality product. Alternatively, in a market characterized by relatively low heterogeneity in taste preference, the firm should post bestseller information only if it is the low-quality product. The firm should announce the high quality product as the bestseller when there is high heterogeneity in valuation for quality and the low quality product when the heterogeneity in quality valuation is low. We find that the quality difference between the two products also impacts the announcement decision. A noteworthy result is that low quality brand should be revealed as the bestseller only when the quality difference between the two products is relatively large.

Interestingly, the results show that the firm should reveal either product as the bestseller, only when the heterogeneity occurs in one of the two dimensions. If consumers highly differ in both the taste preferences as well as in their valuation for quality, then the firm should not make any bestseller announcement. Analogously, when the heterogeneity is low on both dimensions also, the firm is better off not revealing the bestseller.

We also find that under the parametric conditions where it is optimal for the firm to disclose the bestseller, consumer surplus declines. Surprisingly, consumers are worse off when additional information is provided, ostensibly to help in their purchase decision process.

We experimentally test the major assumption of the model which is that bestseller information can shift consumer preferences. We also present empirical evidence that firms' pricing strategy is related to revealing their bestsellers: data from one retailer shows that they offer lower discounts on their better selling items.

We do not model competition for two reasons. If competing firms are targeting the same set of consumers with a similar product portfolio, then both firms should reveal (or not reveal) their bestsellers. For example, both Best Buy and Circuit City post their bestsellers. On the other hand, as the model suggests, if the target segments differ in terms of customer heterogeneity or if the quality difference within the product line vary, then the decision is likely more driven by these customer and product characteristics rather than competitive considerations. For example, consistent with the model, the quality difference in the product line carried by HP who does post bestsellers is much greater than Dell who does not post their bestsellers (*Forrester* 2005). Also as the model suggests, anecdotal evidence indicates that the heterogeneity in Costco's customer base who announces their bestsellers is greater than Sam Club's customer base who does not announce their bestsellers (e.g., *Motley Fool* 2006,

Quantcast.com 2007). The second reason for not modeling competition is that the model becomes intractable and we not believe that adding this complexity provides any further useful insights.

### **MODEL**

**Firm.** We consider a firm that sells two differentiated products,  $\{H, L\}$ , that belong to a common product category. The two products are vertically differentiated -  $H$  is the higher quality, higher priced product, relative to product  $L$ . We assume that the qualities are exogenously determined. The product qualities are denoted by  $q_h$  and  $q_l$  respectively, with  $q_h > q_l > 0$  and correspondingly, their prices are denoted by  $p_h$  and  $p_l$  respectively, with  $p_h > p_l > 0$ . Without loss of generality, we normalize the quality of the products as  $q_l = 1$  and  $q_h = q > 1$ . Thus,  $q$  indicates the ratio of the product qualities of the two products.

The two products are also horizontally differentiated, located at the two ends of a Hotelling (1929) line of length  $\beta > 0$ . We assume that the two products are optimally located at the ends of the linear market. The length of the Hotelling line signifies the extent of horizontal differentiation. For example, consider a store that stocks two cameras where one camera has 6 shooting modes and the other has 8. The differentiation here is much lower than in a store that stocks two cameras – one with 4 shooting modes and the other with 12 modes. Without loss of generality, suppose product  $H$  is located at the left end of the Hotelling line,  $x = 0$  while product  $L$  is located at the right end  $x = \beta$ .

There are no income effects in this market and the prices of  $H$  and  $L$  are such that both products are affordable by all consumers. Each consumer decides to purchase either product  $H$ , or product  $L$ , or purchase neither product.

The firm's sales are represented by  $s_h$  and  $s_l$  respectively. Based on its recent sales history, the firm privately knows whether the higher quality product  $H$  or the lower quality product  $L$  is the bestseller. The firm decides whether to reveal or not reveal this bestseller information to the consumers. The firm is not allowed to lie to consumers and in case it decides to reveal this information, it does so truthfully<sup>2</sup>. Our framework considers the bestseller problem as a simplified static model. It is possible that the firm makes an announcement decision every period making this a dynamic multi-period problem. However in practice, we observe that firms maintain their revelation strategy. We therefore impose a condition where sales of the bestseller must exceed the non-bestsellers in the current period. Three scenarios can occur in the model (i) The firm does not reveal the bestseller (ii) Product  $H$  is the bestseller and the firm reveals this information and (iii) Product  $L$  is the bestseller and the firm reveals this information.

**Consumers.** Consumers are heterogeneous and uniformly distributed along two dimensions: First, consumers are heterogeneous in their marginal valuation for product quality represented by  $y \in [0, \alpha]$ . Second, consumers are heterogeneous in their location on the Hotelling line represented by  $x \in [0, \beta]$ . Every consumer in the market is characterized by a unique pair of parameters  $(x, y)$ , distributed across a two-dimensional space of area  $\alpha\beta$ . A consumer located at point  $(x, y)$  has a marginal valuation of quality  $y$ . Consumers who have higher marginal valuation for quality are willing to pay a higher price for any given quality level. The quality variable captures the composite of all the more-is-better types of product features. A consumer gains a utility of  $yq$  from purchasing product  $H$  or alternately, a utility of  $y$  from purchasing product  $L$ .

---

<sup>2</sup> Federal and state regulations require that firms not deceive consumers.

Consumers are also heterogeneous in their taste preferences and are uniformly located in a linear market (Hotelling 1929). Taste attributes capture differences in preferences for attributes where more is not always better and consumers have their individual ideal points. These attributes include design, form and product size. Consider the consumer located at point  $x$ . The location  $x$  represents the ideal composite of taste attributes desired by the consumer. This consumer is located at a horizontal distance  $x$  away from product  $H$  and a horizontal distance  $(\beta - x)$  away from product  $L$ . Consumers incur a transportation cost from purchasing either product  $H$  or  $L$ . This transportation cost measures the magnitude of misfit between a consumer's ideal preferences and indicates the disutility suffered by the consumer by purchasing a product that does not best fit their ideal point. Let  $t_h$  and  $t_l$  represent the consumers' transportation cost per unit distance, with respect to products  $H$  and  $L$  respectively. Therefore the consumer located at point  $(x, y)$  incurs a transportation cost of  $t_h x$  if she purchases product  $H$ , while she incurs a transportation cost of  $t_l(\beta - x)$  if she purchases product  $L$ .

We depart from papers that consider a Hotelling market of unit length and used the transportation cost parameter  $t$  to model both the level of heterogeneity in the market as well as the disutility per unit length that consumers incur from purchasing a product away from their ideal points (See for example, Kim and Serfes 2006). In our model, we separate the impact of consumer heterogeneity and consumer disutility. We endogenize the length of the Hotelling line as  $\beta > 0$  and model  $\beta$  as a variable measuring the level of heterogeneity in the market. The transportation cost parameters  $(t_h, t_l)$  solely reflect the disutility incurred by consumers located on the Hotelling line from purchasing products  $H$  or  $L$  respectively.

Consumers are uncertain of their preferences or more specifically the relative weights they should assign to attributes. The impact of the bestseller information is that consumers'

uncertainty on the relative weights of attributes reduces (relative to when no bestseller is announced). In modeling terms, their unit transportation costs  $t_h$  and  $t_l$  change. Consider the case when the low-quality product  $L$  is the bestseller. When  $L$  is announced to be the bestseller, consumers use the information on the revealed preferences of other consumers to reduce their uncertainty of whether product  $L$  better matches their preferences. This reduction in uncertainty shifts their preferences towards the bestseller ( $t_l$  declines and  $t_h$  increases),. We experimentally test the assumption that bestseller information shifts consumer preferences in Section 6 and find empirical support for it.

We model bestseller information to impact perceptions of product compatibility with consumer tastes rather than change consumers' perceived quality of the product. We use this approach as vertical differentiation is generally viewed to be on "more is better" attributes (Desai 2001) where consumers can easily discern quality. Bestseller information is more likely to be used for taste type features where attribute information is more difficult to determine such as experiential attributes (Hoch and Ha 1986) or for products with image related attributes (West and Broniarczyk 1998). For tractability, we capture all such phenomena where there is underlying uncertainty of information or where preferences are being constructed in the taste preference parameter.

Summarizing the above framework, we can express the consumers' utility functions from purchasing products  $H$  and  $L$  as  $U_h(x, y) = yq - p_h - t_h x$  and  $U_l(x, y) = y - p_l - t_l(\beta - x)$ . Also, following the standard literature, the marginal cost for products  $H$  and  $L$  is a convex function of the level of quality. We assume a simple quadratic cost function,  $c = q^2$ . We can now solve the firm's profit maximization problem (See Appendix A for detailed steps). Tables 1-

3 show the equilibrium solutions in base case, when the  $L$  is the bestseller and when  $H$  is the bestseller. .

### ***Impact of Bestseller Information on Prices, Sales and Consumer Purchase Behavior***

We examine the effect of announcing the bestseller on the equilibrium prices of the products<sup>3</sup>. We also discuss the impact of announcing the bestseller on consumer purchase decisions. We begin by examining the impact on product sales when the lower quality product  $L$  is revealed to be the bestseller. Announcing the bestseller product affects consumer utility in two ways. First, since the equilibrium price of the bestseller is higher after the announcement, this reduces consumer utility from purchasing the bestseller. Second, knowledge of the bestseller increases the consumers' fit with respect to the bestseller, thereby increasing consumer utility.

We examine how the marginal consumers are affected by these two factors. Recall that  $y_l^*$  represents the marginal valuation of quality of consumers indifferent between not purchasing and purchasing product  $L$ . We use Figure 1 to explain the effects. If the bestseller is not announced,  $y_l^*$  indicates the consumers indifferent between not purchasing and purchasing product  $L$ . If  $L$  is announced to be the bestseller,  $y_{l0}^*$  represents the new indifference line. In Figure 1, the triangular area 1 indicates those consumers who react to the bestseller announcement by shifting from not purchasing to purchasing. In contrast, the triangular area 2 indicates the consumers who were initially going to purchase the product but do not if the firm reveals the bestseller. For consumers in area 1, the increase in utility from the increased fit with

<sup>3</sup> We ensure that the price of the high quality product  $H$  exceeds the price of the low quality product  $L$ . This is true if the level of horizontal differentiation between the products is upper-bound as  $\beta < \beta_{\max}$ , where

$$\beta_{\max} = \frac{2(q-1)(\alpha+q+1)}{(t_{h0}-t_{l0})}. \text{ The condition } \beta < \beta_{\max} \text{ also ensures that local monopolies do not form.}$$

the bestseller exceeds the disutility incurred from the higher equilibrium price of the bestseller. On the other hand, for consumers in area 2, the increase in price does not offset the increase in utility from improved fit.

To see the impact of the bestseller announcement, consider three hypothetical consumers  $A$ ,  $B$  and  $C$  denoted in Figure 1. These three consumers have the same marginal valuation for quality but differ in their taste preferences. Consumers  $A$  and  $C$  are unaffected by the bestseller announcement. Observe that consumer  $A$  continues to not purchase either product regardless of whether  $L$  is announced or not announced to be the bestseller. Similarly, consumer  $C$  continues to purchase  $L$  even after it is announced to be the bestseller. In contrast, consumer  $B$  shifts from not purchasing to purchasing the bestseller. This comparison implies that the consumers most affected by the bestseller announcement are those whose tastes are not extremely close to either product. Intuitively, these are the consumers who are relatively undecided about which products best fits their needs.

The second observation easily discerned from Figure 1 is that area 1 is larger than area 2, suggesting that the number of consumers who switch from non-buyers to buyers is larger than the number of consumers who do the opposite.

We now turn our attention to consumers who were indifferent between purchasing product  $H$  or  $L$ . When the bestseller product is not announced,  $y_{hl}^*$  represents the consumers who are indifferent between purchasing products  $H$  and  $L$ .  $y_{hl0}^*$  represents the marginal consumers after the announcement. The triangular area 3 indicates the consumers who switch from buying product  $H$ , to now purchasing the bestseller  $L$ . Correspondingly, the triangular area 4 represents the consumers who switch away from buying the bestseller product  $L$  to now buying the non-bestseller.

Recall that the price of the bestseller  $L$  has increased. Despite the increase in price of  $L$ , consumers in area 3 switch from purchasing  $H$  to  $L$  since their perceived fit with product  $L$  has increased. Consumers in area 4 exhibit interesting behavior. These consumers switch away from the bestseller and purchase product  $H$ . As can be seen, these consumers' preferences are also more closely aligned with the features offered by  $L$ . The intuition for this result can be seen from the lowering of  $t_l$  which is the same for all consumers. Since these consumers' preferences for product  $L$  are strong, the bestseller information has a relatively smaller impact on them – the key driver in their decision making is the increase in price of the bestseller  $L$ . As these consumers also have a high valuation for quality, they make a trade-off between switching to the higher quality product (whose price has reduced) versus paying a higher price for a lower quality product. Surprisingly, some consumers whose taste preferences are most closely aligned with the bestseller do not purchase it after it is announced to be the bestseller.

We now examine the corresponding impact on product sales, when the higher quality product  $H$  is revealed to be the bestseller. The broad effects discussed when product  $L$  is the bestseller also occurs when  $H$  is the bestseller. Consumers' expected fit with respect to product  $H$  increases thus increasing  $H$ 's utility but on the other hand, the increase in the equilibrium price of  $H$  when it is announced to be the bestseller decreases consumers' disutility.

Figure 2 illustrates the effects. When the bestseller is not announced,  $y_{hl}^*$  denotes the consumers indifferent between buying product  $L$  and product  $H$ . If  $H$  is announced to be the bestseller, the consumers indifferent between these two choices are represented by  $y_{hl1}^*$ . Analogous to the earlier case, area 8 represents consumers who switch from purchasing product  $L$  to now purchasing the bestseller  $H$ . For these consumers, the increase in utility from improved fit with the bestseller exceeds the disutility from paying the higher equilibrium price.

Area 7 represents the interesting case of consumers who respond to the bestseller information by now purchasing the non-bestseller. This segment of consumers *ex ante* has a high fit with product  $H$ . The price increase however provides them with a sufficient incentive to switch to the lower quality product. Note that the lower price makes the  $L$  product attractive to these consumers since, as compared to the consumers in Area 8, these consumers valuation for quality is relatively lower.

Again,  $y_l^*$  and  $y_{l1}^*$  denote the consumers indifferent between not purchasing and purchasing  $L$  before and after  $H$  is announced to be the bestseller respectively. Consumers in area 5 switch from purchasing  $L$  to now not purchasing when  $H$  is announced to be the bestseller. It is interesting that such behavior occurs despite the decrease in the equilibrium price of  $L$ . Here, the announcement of  $H$  as the bestseller reduces their fit with  $L$  sufficiently, causing them to drop out of the market. Finally, in area 6, non-buyers now purchase product  $L$  as the combination of the decrease in price and their preference for the features of  $L$  is sufficiently high and causes them to enter the market.

In aggregate, since the size of area 8 exceeds that of area 7, the sales of the bestseller increase after announcement. However, as more consumers drop out of the market than new category buyers enter, revealing  $H$  to be the bestseller reduces category sales. This result is somewhat surprising as it is not obvious that category sales suffer when any product is revealed as the bestseller.

### ***WHEN SHOULD THE BESTSELLER BE ANNOUNCED***

#### ***Case when the Low Quality Product is the Bestseller***

We begin by analyzing the case when the lower quality product  $L$  is the bestseller. We discuss the role of horizontal differentiation, vertical differentiation and the quality difference between

the two products on the decision on whether to reveal or not reveal the bestseller. The equilibrium solution of prices, sales and profits when the low quality product is announced to be the bestseller is summarized in Table 2.

### ***Impact of Horizontal Product Differentiation***

We consider the impact of horizontal product differentiation ( $\beta > 0$ ) on the firm's incentive to reveal the bestseller. In order for  $L$  to be the bestseller, the first necessary requirement is that the sales of  $L$  should indeed exceed the sales of  $H$ , or  $(s_{h0}^* - s_{l0}^*) < 0$ . We refer to this as the truth-telling condition. Substituting the equilibrium sales from Table 2 into  $(s_{h0}^* - s_{l0}^*) < 0$  and simplifying yields the inequality  $2(q-1)(2q+1-\alpha) - \beta((q+1)t_{l0} - 2t_{h0}) > 0$ . This truth-telling

condition can be rewritten as  $\beta < \beta_{t0}$ , where  $\beta_{t0} = \frac{2(q-1)(\alpha - 2q - 1)}{(2t_{h0} - (q+1)t_{l0})}$ . The second

requirement is that the equilibrium sales of  $L$  and  $H$  should be strictly positive, or  $s_{h0}^* > 0$  and  $s_{l0}^* > 0$ . Since we have  $(s_{h0}^* - s_{l0}^*) < 0$ , we only need to check that  $s_{h0}^* > 0$ . Substituting  $s_{h0}^*$

from Table 2 and simplifying yields the inequality  $2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta > 0$ . This

individual-rationality condition can be rewritten as  $\beta < \beta_{ir0}$ , where  $\beta_{ir0} = \frac{2(q-1)(\alpha - q - 1)}{(t_{h0} - t_{l0})}$ .

Thus, the feasible level of horizontal differentiation over which the firm decides whether to reveal or not reveal the bestseller occurs when both the above requirements are collectively met, given by  $0 < \beta < \text{Min}\{\beta_{ir0}, \beta_{t0}\}$ .

When the low quality product  $L$  is the bestseller, the third necessary requirement for the firm to reveal it to be the bestseller is that the profits accrued from the announcement should be greater than the base case where no announcement is made ( $\Delta\Pi_0^* = \Pi_0^* - \Pi^* > 0$ ). Substituting the equilibrium profits from Tables 1 and 2, and simplifying yields the inequality

$4(q-1)(t_{h0}(q+1) - t_{l0}q - 1) - 4(q-1)(t_{h0} - 1)\alpha - \beta(q(1-t_{l0}^2) - t_{h0}^2 + 2t_{h0}t_{l0} - 1) > 0$ . This incentive-compatibility condition can be in turn, rewritten as  $0 < \beta < \beta_{ic0}$ , where we note that

$$\beta_{ic0} = \frac{4(q-1)((t_{h0} - 1)\alpha + (t_{l0}q + 1) - t_{h0}(q+1))}{(t_{h0}^2 - 2t_{h0}t_{l0} + 1 - q(1-t_{l0}^2))}.$$

Taken together, the analysis indicates that the firm faces three possible strategies:  $\{c, d, r\}$ , where  $c$  represents that the firm cannot reveal the bestseller;  $d$  represents that the firm does not reveal the bestseller, while  $r$  represents that the firm reveals the bestseller. This leads to Proposition 1(a).

Proposition 1(a)

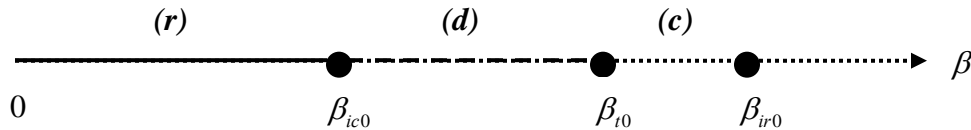
*The firm reveals (r) the lower quality product L to be the bestseller when  $0 < \beta < \beta_{ic0}$ .*

*The firm does not (d) reveal L to be the bestseller when  $\beta_{ic0} < \beta < \text{Min}\{\beta_{ir0}, \beta_{l0}\}$ .*

*The firm cannot (c) reveal L to be the bestseller when  $\beta > \text{Min}\{\beta_{ir0}, \beta_{l0}\}$ , where*

$$\beta_{ic0} = \frac{4(q-1)((t_{h0} - 1)\alpha + (t_{l0}q + 1) - t_{h0}(q+1))}{(t_{h0}^2 - 2t_{h0}t_{l0} + 1 - q(1-t_{l0}^2))}$$

$$\beta_{ir0} = \frac{2(q-1)(\alpha - q - 1)}{(t_{h0} - t_{l0})}, \quad \beta_{l0} = \frac{2(q-1)(\alpha - 2q - 1)}{(2t_{h0} - (q+1)t_{l0})}$$



The proof of the Proposition is provided in Appendix B. Proposition 1(a) indicates that over the feasible range,  $\beta$  should be below a threshold in order for  $L$  to be announced to be the bestseller. The intuition is as follows: recall that with increasing  $\beta$ , the equilibrium prices of both products decline due to increased consumers' perception of misfit. At sufficiently high levels of  $\beta$ , the benefit that is accrued by increasing the price of  $L$  is not enough to offset the strong lowering of price that is required due to an increase in consumers' perception of misfit.

To see the impact of increasing  $\beta$  on sales, please refer to Figure 1. Consider the impact of an increase in  $\beta$  on the slopes and intercepts of the indifference lines  $y_{l0}^*$  and  $y_{hl0}^*$ . With increasing  $\beta$ , the indifference line  $y_{l0}^*$  shifts upwards, increasing its intercept, but leaving its slope unaffected. On the other hand, the indifference line  $y_{hl0}^*$  shifts downwards, with the same slope. The overall impact of increasing  $\beta$  is that the sales of  $L$  get squeezed due to two effects. First, the number of new customers entering the market decreases. Second, consumers shift from purchasing  $H$  to purchasing  $L$ . Thus, at a high-enough level of  $\beta$ , the loss of sales and the low price of  $L$  collectively make it unprofitable for the firm to reveal that  $L$  is the bestseller. Meanwhile, the price of  $H$  decreases, both with increasing  $\beta$ , as well as with the announcement of  $L$  as the bestseller. Even though the sales of  $H$  increase in  $\beta$ , the firm's overall profits decline. Therefore, the firm is better off announcing the lower-quality product  $L$  to be the bestseller only at relatively low levels of horizontal product differentiation ( $\beta$ ).

### ***Impact of Vertical Product Differentiation***

We now consider the impact of vertical product differentiation on the firm's incentive to reveal the bestseller. Recall that  $\alpha$  measures the sensitivity and heterogeneity among consumers with regard to their willingness-to-pay for product quality, while  $q$  captures the exogenous difference in quality between the two available products.

From Proposition 1(a), we know that the level of horizontal product differentiation necessary for the firm to reveal  $L$  to be the bestseller is bounded as  $0 < \beta < \beta_{ic0}$ . Let us consider a market where  $\beta$  satisfies this range. Assuming that  $\beta$  satisfies this range, there are three necessary conditions in order for the firm to reveal  $L$  to be the bestseller: sales of  $L$  should exceed  $H$ , sales of both products should be positive and the firm should be more profitable with bestseller revelation. Following the logic used earlier yields Proposition 1(b).

Proposition 1 (b)

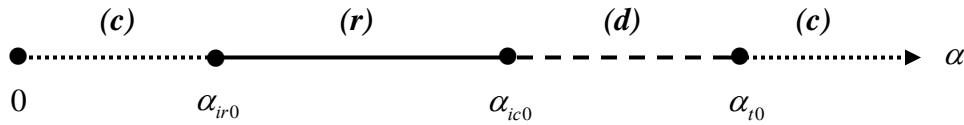
The firm reveals (r) the lower quality product  $L$  to be the bestseller when  $\alpha_{ir0} < \alpha < \alpha_{ic0}$ .

The firm does not (d) reveal  $L$  to be the bestseller when  $\alpha_{ic0} < \alpha < \alpha_{i0}$ .

The firm cannot (c) reveal  $L$  to be the bestseller when,  $0 < \alpha < \alpha_{ir0}$  and  $\alpha > \alpha_{i0}$  where

$$\alpha_{ir0} = (q-1) + \frac{(t_{h0} - t_{l0})\beta}{2(q-1)}, \quad \alpha_{i0} = (2q+1) + \frac{\beta(2t_{h0} - (q+1)t_{l0})}{2(q-1)}$$

$$\alpha_{ic0} = \frac{t_{h0}(q-1) - (t_{l0}q+1)}{(t_{h0}-1)} + \frac{\beta(t_{h0}^2 - 2t_{h0}t_{l0} + 1 - q(1-t_{l0}^2))}{4(q-1)(t_{h0}-1)}$$



For brevity, we omit proofs for the remaining propositions. Proposition 1(b) indicates that there exists an upper bound in the marginal valuation in quality after which it is not profitable for the firm to announce the low quality product  $L$  to be the bestseller. The intuition behind this result rests on the following trade-off: On one hand, announcing  $L$  as the bestseller increases its sales and price, leading to an increase in the profit made by the firm. On the other hand, all else equal, high  $\alpha$  implies high sales and margins of  $H$  which also leads to an increase in the firm's profit. If  $\alpha$  is sufficiently high, the second effect dominates the first effect which makes it suboptimal for the firm to announce the low quality product  $L$  as the bestseller.

Therefore,  $L$  should be posted as the bestseller only when  $\alpha$  is below a threshold.

Next, we analyze how the difference in product quality ( $q$ ) between  $H$  and  $L$  moderates the incentive to reveal  $L$  to be the bestseller. We proceed in a manner similar to the one adopted while studying the role of  $\alpha$ . We assume that  $\beta$  satisfies the bounds necessary in order for the firm to reveal  $L$  to be the bestseller. We reconsider the three conditions specified above, but

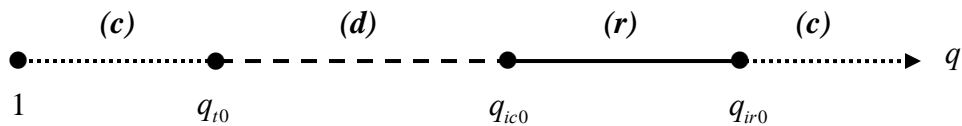
now with respect to  $q$  and identify the different ranges of  $q$  where firm reveals, does not reveal or cannot reveal  $L$  to be the bestseller  $\{r, d, c\}$ , summarized below in Proposition 1(c).

Proposition 1(c)

*The firm reveals (r) the lower quality product  $L$  to be the bestseller when  $q_{ic0} < q < q_{ir0}$ .*

*The firm does not (d) reveal  $L$  to be the bestseller when  $q_{t0} < q < q_{ic0}$ .*

*The firm cannot (c) reveal  $L$  to be the bestseller when,  $1 < q < q_{t0}$  and  $q > q_{ir0}$*



According to Proposition 1(c), the quality difference between the two products should exceed a threshold for the firm to profitably reveal that  $L$  is the bestseller. The intuition behind this result is as follows. The effect of announcing  $L$  to be the bestseller causes the price to increase leading to some consumers dropping out of the market (area 2 in Figure 1). Also, announcing  $L$  to be the bestseller improves the fit of some consumers and causes new customers to enter the market (area 1 in Figure 1). With increasing quality difference between the two products, the magnitude of these effects remains unchanged. Note that in our model, the quality of the low quality product has been normalized to 1. An increase in  $q$  does not impact the price of the  $L$  product. This implies that the purchase/no purchase decision is unaffected by the quality difference. Thus, the net impact of the announcement only influences the switching between the  $H$  and  $L$  products, with overall sales remaining constant. The impact of  $q$  on the decision to announce the bestseller then hinges on the magnitude of the cannibalization effect.

When the quality difference between the two products is high, the relative price difference between the products is also correspondingly high. The announcement of  $L$  as the bestseller increases  $L$ 's price but reduces  $H$ 's price. However the relative decline in the price of

$H$ , representing lost revenue for the firm is smaller when the quality difference between  $H$  and  $L$  is higher. This explains why the firm gains from revealing  $L$  to the bestseller only when  $q$  is sufficiently high.

Another way of thinking about this is in terms of the misfit experienced by the consumers with regard to the non-bestseller. When  $L$  is revealed to the bestseller, consumers experience a greater misfit from purchasing the non-bestseller  $H$ . This prompts the firm to compensate consumers by lowering the price of the non-bestseller  $H$ . However, the resulting relative loss in revenue is lower when the quality difference is itself larger. The cannibalization effect then reduces at higher levels of the quality difference. Thus, only beyond some threshold value of  $q$ , it is optimal for the firm to reveal  $L$  to be the bestseller.

### ***Case when the High Quality Product is the Bestseller***

#### ***Impact of Horizontal Product Differentiation***

We now analyze the case when the higher quality product  $H$  is the bestseller. The equilibrium solution of prices, sales and profit when  $H$  is announced to be the bestseller is summarized in Table 3.

Analogous to the earlier case, there are three conditions necessary for the firm to reveal  $H$  to be the bestseller. First, the sales of  $H$  should exceed the sales of  $L$ , or  $(s_{h1}^* - s_{l1}^*) > 0$ .

Substituting the closed-form expressions for the sales from Table 3, this yields the

inequality  $2(q-1)(2q+1-\alpha) - \beta((q+1)t_{l1} - 2t_{h1}) < 0$ . This truth-telling condition can be

rewritten as  $\beta > \beta_{l1}$ , where  $\beta_{l1} = \frac{2(q-1)(2q+1-\alpha)}{((q+1)t_{l1} - 2t_{h1})}$ . Second, the equilibrium sales of  $L$  and  $H$

should be strictly positive, or  $s_{h1}^* > 0$  and  $s_{l1}^* > 0$ . Since  $(s_{h1}^* - s_{l1}^*) > 0$ , we only need to check

that  $s_{l1}^* > 0$ , yielding the inequality  $2q(q-1) - \beta(qt_{l1} - t_{h1}) > 0$ . This individual-rationality

condition can be rewritten as  $\beta < \beta_{ir1}$ , where  $\beta_{ir1} = \frac{2q(q-1)}{qt_{l1} - t_{h1}}$ . Thus, the feasible level of

horizontal differentiation over which the firm decides whether to reveal or not reveal  $H$  as the

bestseller occurs when both the above requirements are collectively met, given by  $\beta_{t1} < \beta < \beta_{ir1}$ .

Third, the profit from announcing  $H$  to be the bestseller should exceed the profit from not

announcing the bestseller, or ( $\Delta\Pi_1^* = \Pi_1^* - \Pi^* > 0$ ). This incentive-compatibility condition

yields  $\beta > \beta_{ic1}$ , where  $\beta_{ic1} = \frac{4(q-1)((t_{l1} - t_{h1})q - (1 - t_{h1})(\alpha - 1))}{(t_{h1}^2 - 2t_{h1}t_{l1} + 1 + q(t_{l1}^2 - 1))}$ .

Taken together, the analysis indicates the level of horizontal differentiation where the firm cannot reveal ( $c$ ), does not reveal ( $d$ ) and reveals ( $r$ ) the higher-quality product  $H$  to be the bestseller. This is summarized below in Proposition 2(a).

Proposition 2(a)

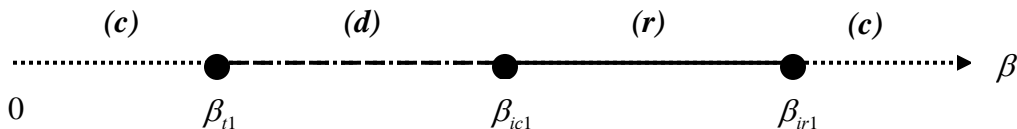
*The firm reveals ( $r$ ) the higher quality product  $H$  to be the bestseller when  $\beta_{ic1} < \beta < \beta_{ir1}$ .*

*The firm does not ( $d$ ) reveal  $H$  to be the bestseller when  $\beta_{t1} < \beta < \beta_{ic1}$ .*

*The firm cannot ( $c$ ) reveal  $H$  to be the bestseller when  $0 < \beta < \beta_{t1}$  and  $\beta > \beta_{ir1}$ , where*

$$\beta_{ic1} = \frac{4(q-1)((t_{l1} - t_{h1})q - (1 - t_{h1})(\alpha - 1))}{(t_{h1}^2 - 2t_{h1}t_{l1} + 1 + q(t_{l1}^2 - 1))}$$

$$\beta_{ir1} = \frac{2q(q-1)}{qt_{l1} - t_{h1}}, \quad \beta_{t1} = \frac{2(q-1)(2q+1-\alpha)}{((q+1)t_{l1} - 2t_{h1})}$$



Proposition 2(a) indicates that  $\beta$  should be above a threshold for the firm to have an incentive to reveal the higher-quality product  $H$  to be the bestseller. The intuition behind this

result can be gleaned by examining the impact of the profitability on  $H$  and  $L$  when  $\beta$  is increasing (in the domain where it is feasible for the firm to reveal the bestseller). As can be seen in Figure 2, when  $\beta$  increases,  $y_{h1}^*$  shifts relatively downward, while  $y_{l1}^*$  shifts relatively upwards. This implies that the sales of  $H$  increase with an increase in  $\beta$ . Also, when  $H$  is announced as the bestseller, the price of  $H$  increases. Together,  $H$ 's profitability goes up.

Let us now examine the impact on the profitability of  $L$ . At high levels of  $\beta$ , the price of  $L$  declines naturally. Also, the prices have to be further lowered since  $H$  is the bestseller.

Therefore, there is a double-whammy effect on the price of  $L$ .

However, as discussed earlier, with increasing  $\beta$ , the sales of  $L$  get squeezed at both ends (market entry and switching). Since the sales are low to begin with, the effect on  $L$ 's profitability is not great when  $H$  is posted as the bestseller. Overall then, at high enough levels of  $\beta$ , it is worthwhile for the firm to reveal the high quality product to be the bestseller.

### ***Impact of Vertical Product Differentiation***

We finally analyze the impact of vertical product differentiation on the firm's incentive to reveal the bestseller, when the higher quality product  $H$  is the bestseller. Once again, the necessary equilibrium conditions necessary to reveal  $H$  to be the bestseller arise from the truth-telling, individual rationality and incentive compatibility constraints described above, leading to Proposition 2(b).

Proposition 2(b)

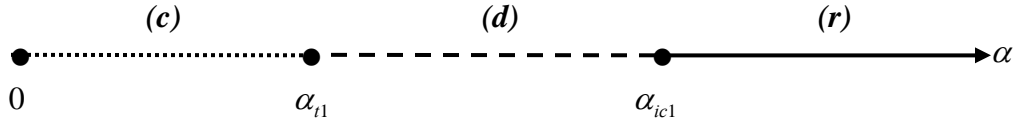
*The firm reveals (r) the higher quality product  $H$  to be the bestseller when  $\alpha > \alpha_{ic1}$ .*

*The firm does not (d) reveal  $H$  to be the bestseller when  $\alpha_{i1} < \alpha < \alpha_{ic1}$ .*

*The firm cannot (c) reveal  $H$  to be the bestseller when,  $0 < \alpha < \alpha_{i1}$  where*

$$\alpha_{i1} = (2q + 1) - \frac{\beta((q + 1)t_{l1} - 2t_{h1})}{2(q - 1)}$$

$$\alpha_{ic1} = \frac{4(q-1)((t_{l1} - t_{h1})q + (1 - t_{h1})) - \beta(t_{h1}^2 - 2t_{h1}t_{l1} + 1 + q(t_{l1}^2 - 1))}{4(q-1)(1 - t_{h1})}.$$



Within the feasible range where the firm has a decision to make, the firm announces  $H$  as the bestseller only above a threshold  $\alpha$ . The intuition behind this result is as follows. A low  $\alpha$  implies that consumers have a low willingness to pay for quality and are not inherently predisposed to the high quality product. Announcing  $H$  to be the bestseller raises its price. If  $\alpha$  is low, the increase in the already high prices of  $H$  dissuades consumers from switching from  $L$ . This unwillingness to pay more overcomes any improvement in the consumers' perception of fit with respect to product  $H$ . Therefore, the firm finds it optimal to reveal  $H$  to be the bestseller only when the average marginal valuation for product quality among the consumers exceeds a threshold.

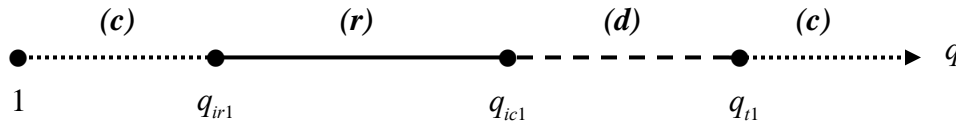
Next, we analyze how the quality difference  $q$  between  $H$  and  $L$  influences the incentive to reveal  $H$  to be the bestseller. We proceed in a manner similar to the one adopted while studying the role of  $\alpha$ . We assume that  $\beta$  satisfies the bounds necessary in order for the firm to reveal  $H$  to be the bestseller. We reconsider the three necessary conditions specified above, but with respect to  $q$  and identify the different ranges of  $q$  where firm reveals, does not reveal or cannot reveal  $H$  to be the bestseller  $\{r, d, c\}$ . These are summarized in Proposition 2(c) below:

Proposition 2(c)

*The firm reveals (r) the higher quality product  $H$  to be the bestseller when  $q_{ir1} < q < q_{ic1}$ .*

*The firm does not (d) reveal  $H$  to be the bestseller when  $q_{ic1} < q < q_{il1}$ .*

*The firm cannot (c) reveal  $H$  to be the bestseller when,  $1 < q < q_{ir1}$  and  $q > q_{il1}$ .*



Proposition 2 (c) says that over the feasible range, the firm finds it optimal to reveal  $H$  to be the bestseller only below a threshold value of  $q$ . Recall from the earlier discussion that the quality difference between the two products does not influence consumers' purchase/ no purchase decision. The decision depends on the cannibalization effect. The profitability of the strategy of announcing  $H$  as the bestseller increases as more consumers switch to purchasing the  $H$  product and are willing to pay its higher price. At relatively high  $q$  the price of  $H$  is already high. With the announcement, this price further increases due to effect of the improvement in fit. For sufficiently high enough quality differences, the price increase becomes so prohibitively high that consumers no longer switch from the  $L$  product. Hence it is optimal for the firm to reveal the bestseller only if  $q$  is sufficiently small.

We also conduct numerical simulations to verify the propositions. These are provided in Appendix C.

### ***Interaction between the level of Horizontal and Vertical Product Differentiation***

We now analyze how the levels of horizontal ( $\beta$ ) and vertical ( $\alpha$ ) product differentiation collectively impact the firm's decision to reveal the bestseller. Our key finding is that the firm does not find it optimal to reveal the bestseller when the levels of horizontal and vertical differentiation are either both high or are both low. This negative correlation between the level of horizontal and vertical differentiation is necessary for the firm to reveal the bestseller, regardless of whether the lower-quality product  $L$  or the higher-quality product  $H$  or the bestseller. For expositional purposes, we discuss the intuition using a numerical example rather

than the closed form solutions. The negative correlation is illustrated in the plot between  $\alpha$  and  $\beta$  in Figure 5 when  $L$  is the bestseller and in Figure 6 when  $H$  is the bestseller, respectively.

The intuition behind the above result is as follows. We first elaborate on why both  $\alpha$  and  $\beta$  cannot be relatively low over the feasible range. When the bestseller is announced, the sales of the bestseller as well as the non-bestseller are both increasing in  $\alpha$  and  $\beta$ . As can be seen in Figure 3, over the feasible range where the firm announces  $L$  to be the bestseller, ( $0 < \beta < 2.8$ ), both the sales  $s_{l0}^*$  and  $s_{h0}^*$  are increasing in  $\beta$ . Also, from Figure 5, observe that over the feasible range where the firm announces  $H$  to be the bestseller, ( $4.8 < \beta < 5.4$ ), both  $s_{l1}^*$  and  $s_{h1}^*$  are increasing in  $\beta$ . The same pattern holds with respect to  $\alpha$ . When both  $\alpha$  and  $\beta$  are relatively low, sales and profits reduce making it sub-optimal for the firm to reveal the bestseller.

Let us now consider the intuition behind why the firm does not reveal the bestseller if both  $\alpha$  and  $\beta$  are relatively high over the feasible range. An increase in  $\alpha$  and  $\beta$  reduces the number of consumers who enter the market and make a purchase. Consider the consumers indifferent between not purchasing and making a purchase (given by  $y_{l0}^*$  and  $y_{l1}^*$  in Tables 2 and 3) when  $L$  and  $H$  are respectively announced to be the bestseller. Observe that the intercepts of both indifference lines are strictly increasing in  $\alpha$  as well as  $\beta$ . The number of consumers entering the market is severely affected at sufficiently high levels of  $\alpha$  and  $\beta$  making it sub-optimal for the firm to reveal the bestseller.

To summarize, the ideal levels of horizontal and vertical differentiation such that the firm profitably reveals the bestseller are negatively correlated – both cannot be simultaneously high or low.

**IMPACT OF BESTSELLER INFORMATION ON CONSUMER SURPLUS**

We now evaluate the impact of the firm revealing the bestseller on consumer surplus. We measure the consumer surplus of the customers who purchase the higher quality product  $H$  as follows:

$CS_h^* = \int_0^\beta \int_{y_{hl}^*}^\alpha (yq - p_h^* - t_h x) dy dx$ . Substituting  $p_h^*$  and  $y_{hl}^*$  and integrating yields the following expression:

$$CS_h^* = \frac{\beta}{96(q-1)^2} \left[ 12q(q-1)^2((\alpha-q)^2 - 1) - 12\beta(q-1)(t_h(q-1)\alpha - t_h(q^2 - q - 1) - t_l q) + \beta^2(7(q-2)t_h^2 - 2t_h t_l - 7qt_l^2) \right]$$

Similarly, we measure the consumer surplus of customers who purchase the lower quality

product  $L$  as follows:  $CS_l^* = \int_0^\beta \int_{y_l^*}^{y_{hl}^*} (y - p_l^* - t_l(\beta - x)) dy dx$ . Substituting  $p_l^*$ ,  $y_l^*$ ,  $y_{hl}^*$  and integrating yields the following expression:

$$CS_l^* = \frac{[q(2q-2+t_l\beta) + 3t_h\beta]^3 - [q(2q-2+3t_l\beta) - t_h\beta]^3}{384(q-1)^2(t_h + qt_l)}$$

The aggregate surplus  $CS^* = CS_h^* + CS_l^*$  yields the following expression:

$$CS^* = \frac{\beta}{96} \left[ 12q((\alpha-q)^2 + q-1) - 12\beta(t_h(\alpha-q-1) + t_l q) + \frac{\beta^2(7t_h^2 + 2t_h t_l + 7qt_l^2)}{(q-1)} \right]$$

We normalize  $t_h = t_l = 1$  in the base case when the firm does not announce the bestseller. When the firm announces the lower quality product  $L$  to be the bestseller, consumers' perception of fit with respect to  $L$  improves while the fit with respect to the non-bestseller  $H$  weakens. This implies  $t_{h0} > 1$ ;  $t_{l0} < 1$ . Analogously, when the firm announces  $H$  to be the bestseller, we obtain  $t_{h1} < 1$ ;  $t_{l1} > 1$ .

The corresponding expressions for the consumer surplus when the firm does not announce the bestseller, announces  $L$  to be the bestseller, announces  $H$  to be the bestseller are

listed in Tables 1-3 respectively. Comparing the surplus when the firm reveals the bestseller relative to when it does not leads to Proposition 3.

### Proposition 3

*The consumer surplus reduces when the firm reveals the bestseller.*

Regardless of whether  $L$  or  $H$  is the bestseller, consumer surplus reduces when the firm reveals the bestseller. We find that it is analytically intractable to prove Proposition 3. We use numerical simulation in order to illustrate this Proposition. The results when the low quality product  $L$  is the bestseller are illustrated in the top right panel of Figure 3. In the range ( $0 < \beta < 2.8$ ) where it is optimal for the firm to reveal the bestseller, the change in surplus ( $\Delta CS_0^* = CS_0^* - CS^* < 0$ ) is always negative. Similarly, the middle panels of Figure 3 also show that over the range where the firm reveals  $L$  as the bestseller ( $4.2 < \alpha < 5.1$ ), the consumer surplus decreases. Finally, the bottom panels illustrate that over the profitable announcement range ( $2.95 < q < 3.9$ ), the change in consumer surplus  $\Delta CS_0^*$  is negative. Thus, consumers are always worse off when the low quality product  $L$  is announced to be the bestseller.

Figure 5 illustrates the corresponding changes in consumer surplus when the higher quality product  $H$  is revealed to be the bestseller as compared to when it is not revealed as the bestseller. The top, middle and bottom panels show that over the feasible range ( $4.6 < \beta < 5.2$ ), ( $\alpha > 6.8$ ) and ( $2.75 < q < 3.2$ ) where the firm finds it profitable to reveal  $H$  as the bestseller, the consumer surplus ( $\Delta CS_1^* = CS_1^* - CS^* < 0$ ) declines. Thus, regardless of whether  $H$  or  $L$  is the bestseller, the revelation of the bestseller lowers consumer surplus.

### ***EXPERIMENTAL VALIDATION OF MODEL ASSUMPTION***

An assumption of the model is that consumer preferences are influenced by bestseller

information. The objective of the experimental validation is to examine whether the assumption is reasonable. The subjects were undergraduate business major students ( $n = 72$ ) in a major eastern university. Subjects were asked to imagine that they had to purchase an audio-visual receiver for their home theatre and that they visited Circuit City where two receivers were immediately available. The receivers were labeled X and Y. One receiver was more expensive and priced at \$339.99 while the other brand was \$289.99. Eight attributes were used to describe the receivers. Six of the attributes (Watts per channel, Harmonic Distortion, DSP Processing, Warranty and number of Inputs/Outputs) were common to both brands. Two attributes were unique: the expensive brand had “Dual Push-Pull Amplification” and “THX Ultra 2” certification while the cheaper brand was “THX certified” and was “True HD”. Subjects were asked to view the descriptions of the two brands immediately after which they provided measures of purchase intentions. The experiment used a single factor (bestseller) design with three levels. The manipulated factor was whether the brand was described as the bestseller. Either brand X or brand Y was manipulated to be the bestseller by stating “Circuit City’s Bestseller” below the product description. In the control condition, neither brand was described to be the bestseller.

Purchase intentions were measured on a 15-point scale anchored between “Definitely Buy Brand X/Definitely Buy Brand Y. Responses 1-7 indicated higher purchase intentions for Brand X, a response of 8 shows indifference between the two brands and responses 9-15 show that purchase intentions for Brand Y were higher.

In the control condition, the purchase intentions were  $PI_{\text{Control}} = 9.56(3.11)$ <sup>4</sup> indicating a preference for the cheaper brand. As expected, when the more expensive brand was announced to be the bestselling brand, the purchase intentions change significantly towards the bestseller

---

<sup>4</sup> Standard deviation in parenthesis.

( $PI_{\text{Expensive}} = 7.75(3.58) F_{1, 69} = 4.15; p < .05$ ). Also, as anticipated, when the cheaper brand was announced to be the bestseller, the purchase intentions became significantly more extreme towards the cheaper brand ( $PI_{\text{Cheaper}} = 11.27(2.16) F_{1, 69} = 3.13; p < .05$ ). These results support the assumption that announcement of the bestseller does shift purchase intentions.

### ***EMPIRICAL RELATIONSHIP BETWEEN PRICE AND SALES RANK***

The model suggests that by posting bestsellers, it is optimal for the firm to increase the price of the bestseller (or lower the price of the non-bestseller). This is difficult to validate as it requires pricing information pre and post-announcement. As a surrogate, we examine the post-announcement relationship between sales rankings and prices. The pricing approach followed by most firms that do announce bestsellers is to offer discounts from the list prices. As a proxy measure of the impact of bestsellers on pricing, we examine the relationship between the sales ranks of products and the percentage discount offered on list prices. We predict that the firm will discount their bestselling items relatively less than they do products that have lower sales volume. The data was gathered from Amazon in December 2007. The Amazon site provides the list prices, the discounted price and the sales rank of each SKU. We selected two categories – vacuum cleaners and digital cameras. Since different manufacturers have specific agreements with the retailers, we examine the data within the same brand in a given category. The two brands analyzed in the vacuum cleaners were Hoover Uprights ( $n = 17$ ) and Bissell Uprights ( $n = 6$ ). The number in parentheses is the number of SKU's for the brand within the sub category of upright vacuums. These brands were selected as they are major brands in the category. Within digital cameras, the two brands selected were Sony ( $n = 15$ ) and Canon ( $n = 17$ ). Amazon provides relative sales rank for each SKU across all categories. Based on the overall rank, we recoded the data to an ordinal sales rank for each SKU within the brand/category.

The percentage discount on list price was regressed on the ordinal sales rankings separately for each of the four brands. The results are provided in Table 4. In all four cases, the Bestseller Rank coefficient is significant indicating that the retailer offers lower discounts on their bestselling items. It is interesting to note that the  $R^2$  are quite large ranging from 0.25 to 0.71. This analysis lends credence to the notion that pricing is related to the posting of bestseller information.

### *CONCLUSION*

A puzzling phenomenon is why some manufacturers and retailers elect to post their bestsellers for consumers whereas other firms do not. By revealing this information, firms attempt to shift consumer preferences towards their bestselling items. As compared to other marketing mix elements particularly advertising, using bestseller announcements is a relatively costless but powerful tool that can be used to shift demand. The main effect of bestseller information is that consumer preferences swing towards the bestseller and away from the non-bestsellers. The firm can take advantage of the preference change by increasing the prices of the bestseller but has to lower the price of the less popular product. We examine the conditions in which it is profit maximizing for firms to reveal this information and conditions where it is not.

We find that that whether a firm should reveal the bestseller or not depends on the extent of heterogeneity in valuation for quality, the heterogeneity in taste preferences and the quality difference between the two products. The decision to post the bestseller is contingent on whether the firm's bestseller is the high quality-high priced product or whether it is the low price-low quality product.

If the high quality-high price product is the bestseller, it should be announced when heterogeneity in taste preferences is relatively high. In contrast, if the low quality product is the

bestseller, the revelation should be made if heterogeneity in taste preferences is low. When there is high heterogeneity in consumers' valuation for quality, the firm should reveal the bestseller only if it is the high quality product. Analogously, when consumers are relatively homogenous in their valuation for quality, then the firm should post the bestseller only if it is the low quality product.

The decision to post the bestseller is also contingent on the quality difference between the two products. If the quality difference between products is high, then the firm should announce the bestsellers only when the low quality product is the bestseller. If the quality difference is low, then the strategy to proclaim the bestsellers should be followed only if the high quality product is the bestseller.

Using an experimental approach, we find that bestseller information shifts consumer preferences in favor of the bestseller. Using data from Amazon.com, we also find that the firm strategically prices based on sales rank of the product. In the two categories analyzed, Amazon's prices discounts are lower for the bestselling items. Finally, we also show that revealing bestsellers decreases the welfare of consumers. This is a surprising result as it shows that additional information provided to consumers ostensibly to help them in their purchase decision process leaves them worse-off.

One of the major assumptions in the model is that posting the bestseller always decreases perceptions of compatibility with the non-bestseller. The experimental evidence supports this assumption. It is possible though that in some categories like movies and books which are symbolic of identity (Berger and Heath 2007) or other categories where consumers seek uniqueness (Tian, Bearden and Hunter 2001), evidence of one products' popularity could increase some consumers' penchant for the non-bestseller. If this effect is strong enough, the

firm could raise prices for both the bestseller and non-bestseller. Clearly, in such a situation, the consumer welfare would decline further.

One simplification we made is that we model a scenario where there are only two products. We believe that the main results still apply if the products that are bestsellers are generally in the upper price range or the lower price range. There are alternative formats which can also be relatively costless for shifting demand such as posting customer product reviews. The relative benefit of posting these as compared to announcing the bestsellers are worthy of examination. Intuitively, using bestseller information rather than reviews holds two advantages for consumers. First, product reviews do not completely account for product prices. Second, there is a self selection bias in reviews whereas bestsellers are more diagnostic as they indicate revealed preference.

An interesting avenue for future research is to examine the role of bestseller information on channel issues. For example, the implications on manufacturer wholesale pricing decisions when it knows whether it is the bestseller or not are important but so far unclear. Potentially, posting bestsellers could also impact channel co-ordination issues. The role of issues such as strategic decentralization (Desai et al 2004) has received recent attention. In a similar vein, it may be interesting to study how the availability of bestseller influences the pricing and channel coordination between the manufacturer and the retailer. More empirical research also needs to be done to understand the effect of posting bestsellers on consumer behavior. For example, like preannouncements (e.g., Soberman and Gatignon 2005), does bestseller information impact market size by converting consumers' no-buy decision to a buy decision.

## References

- Amaldoss, Wilfred and Sanjay Jain (2005), "Pricing of Conspicuous Goods: A Competitive Analysis", *Journal of Marketing Research*, 42, 30-42.
- Berger, Jonah and Chip Heath (2007), "Where Consumers Diverge from Others: Identity-Signaling and Product Domains," *Journal of Consumer Research*, 34 (2), 121-134.
- Bikhchandani, Sushil, David Hirshleifer and I. Welch (1998), "Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades", *Journal of Economic Perspectives*, 12, 151-170.
- Desai, Preyas (2001) "Quality segmentation in spatial markets: When does cannibalization affect product line design", *Marketing Science*, 20 (3) 265–283.
- \_\_\_\_\_, Sunder Kekre, S. Radhakrishnan and Kannan Srinivasan (2001), "Product differentiation and commonality in design: Balancing revenue and cost drivers", *Management Science*, 47, 37–51.
- \_\_\_\_\_, Oded Koenigsberg and Devavrat Purohit (2004), "Strategic Decentralization and Channel Coordination", *Quantitative Marketing and Economics*, 2 (1), 5-22.
- Dowling, G.R. and R. Staelin (1994), "A model of perceived-risk and risk handling activity" *Journal of Consumer Research*, 21 (3), 119-134.
- Forrester (2005) [http://www.news.com/Commentary-Tough-road-for-new-HP-chief/2030-1069\\_3-5649227.html](http://www.news.com/Commentary-Tough-road-for-new-HP-chief/2030-1069_3-5649227.html)
- Hoch, S.J. and Y. Ha (1986), "Consumer Learning: Advertising and the Ambiguity of Product Experience", *Journal of Consumer Research*, 13, 221-233.
- Hotelling, H. (1929), "Stability in competition", *The Economic Journal* 39, 41-57.

- Kim, H. and K. Serfes (2006), "A location model with preference for variety", *Journal of Industrial Economics*, 54 (4), 569-595
- Miller, L (2000), "The Best-Seller List as Marketing Tool and Historical Fiction", *Book History*, 3 (1), 286-304.
- Motley Fool* (2006), "Dueling Fools: Costco Bull" by Alyce Lomax. November 16.
- Quantcast.com* (2007), <http://www.quantcast.com/sams.com>,  
<http://www.quantcast.com/costco.com>
- Shi, Mengze, J. Chiang and B. D. Rhee (2006), "Price Competition with Reduced Consumer Switching Costs: The Case of "Wireless Number Portability in the Cellular Phone Industry", *Management Science*, 52, 27-38.
- Silverstein, M.J and N. Fiske (2003) "Luxury for the Masses", *Harvard Business Review*
- Soberman, David A. and H. Gatignon (2005), "Research Issues at the Boundary of Competitive Dynamics and Market Evolution", *Marketing Science*, (24) 165-174.
- Sorensen, A. T. (2004), "Bestseller Lists and Product Variety: The Case of Book Sales" *Stanford Working paper 1878*
- Tian, K.T., W.O. Bearden and G.L. Hunter (2001), "Consumers' need for uniqueness: Scale development and validation", *Journal of Consumer Research*, 28, 50-66.
- Tyagi, Rajeev K. (2004), "Technological advances, transaction costs and consumer welfare", *Marketing Science*, 23 (3) 335-344.
- West, P.M. and Susan Broniarczyk (1998), "Integrating Multiple Opinions: The Role of Aspiration Level on Consumer Response to Critic Consensus", *Journal of Consumer Research*, 25, 38-51.

Table 1: Equilibrium solution when the bestseller is not announced ( $t_l = 1$ ), ( $t_h = 1$ ).

	High Quality Product	Low Quality Product
Prices	$p_h^* = \frac{2q(\alpha + q) - \beta}{4}$	$p_l^* = \frac{2(\alpha + 1) - \beta}{4}$
Margins	$m_h^* = \frac{2q(\alpha - q) - \beta}{4}$	$m_l^* = \frac{2(\alpha - 1) - \beta}{4}$
Sales	$s_h^* = \frac{\beta(\alpha - q - 1)}{2}$	$s_l^* = \frac{\beta(2q - \beta)}{4}$
Profits	$\Pi_h^* = \frac{\beta[2q(\alpha - q) - \beta][2(q - 1)(\alpha - q - 1)]}{16(q - 1)}$	$\Pi_l^* = \frac{\beta[2\alpha - 2 - \beta][q(2q - 2 - \beta) + \beta]}{16(q - 1)}$
Marginal Consumers	$y_l^* = \frac{2\alpha + 2 - \beta}{4} + (\beta - x)$	$y_{hl}^* = \frac{(q - 1)\alpha + (q^2 - 1) - 2\beta + 4x}{2(q - 1)}$
Consumer Surplus	$CS_h^* = \frac{\beta}{96(q - 1)^2} [12q(q - 1)^2((\alpha - q)^2 - 1) - 12\beta(q - 1)((q - 1)\alpha - (q^2 - q - 1) - q) - 16\beta^2]$	
	$CS_l^* = \frac{[q(2q - 2 + \beta) + 3\beta]^3 - [q(2q - 2 + 3\beta) - \beta]^3}{384(q - 1)^2(q + 1)}$	
	$CS^* = \frac{\beta}{96} \left[ 12q((\alpha - q)^2 + q - 1) - 12\beta((\alpha - q - 1) + q) + \frac{\beta^2(9 + 7q)}{(q - 1)} \right]$	

Table 2: Equilibrium solution when the low quality product  $L$  is announced to be the bestseller

$$(0 < t_{l0} < 1), (t_{h0} > 1)$$

	High Quality Product	Low Quality Product
Prices	$p_{h0}^* = \frac{2q(\alpha + q) - t_{h0}\beta}{4}$	$p_{l0}^* = \frac{2(\alpha + 1) - t_{l0}\beta}{4}$
Margins	$m_{h0}^* = \frac{2q(\alpha - q) - t_{h0}\beta}{4}$	$m_{l0}^* = \frac{2(\alpha - 1) - t_{l0}\beta}{4}$
Sales	$s_{h0}^* = \frac{\beta[2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta]}{4(q-1)}$	$s_{l0}^* = \frac{\beta[2q(q-1) + (t_{h0} - t_{l0}q)\beta]}{4(q-1)}$
Profits	$\Pi_{h0}^* = \frac{\beta[2q(\alpha - q) - t_{h0}\beta][2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta]}{16(q-1)}$	
	$\Pi_{l0}^* = \frac{\beta[2\alpha - 2 - t_{l0}\beta][q(2q - 2 - t_{l0}\beta) + t_{h0}\beta]}{16(q-1)}$	
Marginal Consumers	$y_{l0}^* = \frac{2\alpha + 2 - t_{l0}\beta}{4} + t_{l0}(\beta - x)$	
	$y_{hl0}^* = \frac{2(q-1)\alpha + 2(q^2 - 1) - (t_{h0} + 3t_{l0})\beta + 4(t_{h0} + t_{l0})x}{4(q-1)}$	
Consumer Surplus	$CS_{h0}^* = \frac{\beta}{96(q-1)^2} \left[ 12q(q-1)^2((\alpha - q)^2 - 1) - 12\beta(q-1)(t_{h0}(q-1)\alpha - t_{h0}(q^2 - q - 1) - t_{l0}q) + \beta^2(7(q-2)t_{h0}^2 - 2t_{h0}t_{l0} - 7qt_{l0}^2) \right]$	
	$CS_{l0}^* = \frac{[q(2q - 2 + t_{l0}\beta) + 3t_{h0}\beta]^3 - [q(2q - 2 + 3t_{l0}\beta) - t_{h0}\beta]^3}{384(q-1)^2(t_{h0} + qt_{l0})}$	
	$CS_0^* = \frac{\beta}{96} \left[ 12q((\alpha - q)^2 + q - 1) - 12\beta(t_{h0}(\alpha - q - 1) + t_{l0}q) + \frac{\beta^2(7t_{h0}^2 + 2t_{h0}t_{l0} + 7qt_{l0}^2)}{(q-1)} \right]$	

Table 3: Equilibrium solution when the high quality product  $H$  is announced to be the bestseller

$$(0 < t_{h1} < 1), (t_{l1} > 1)$$

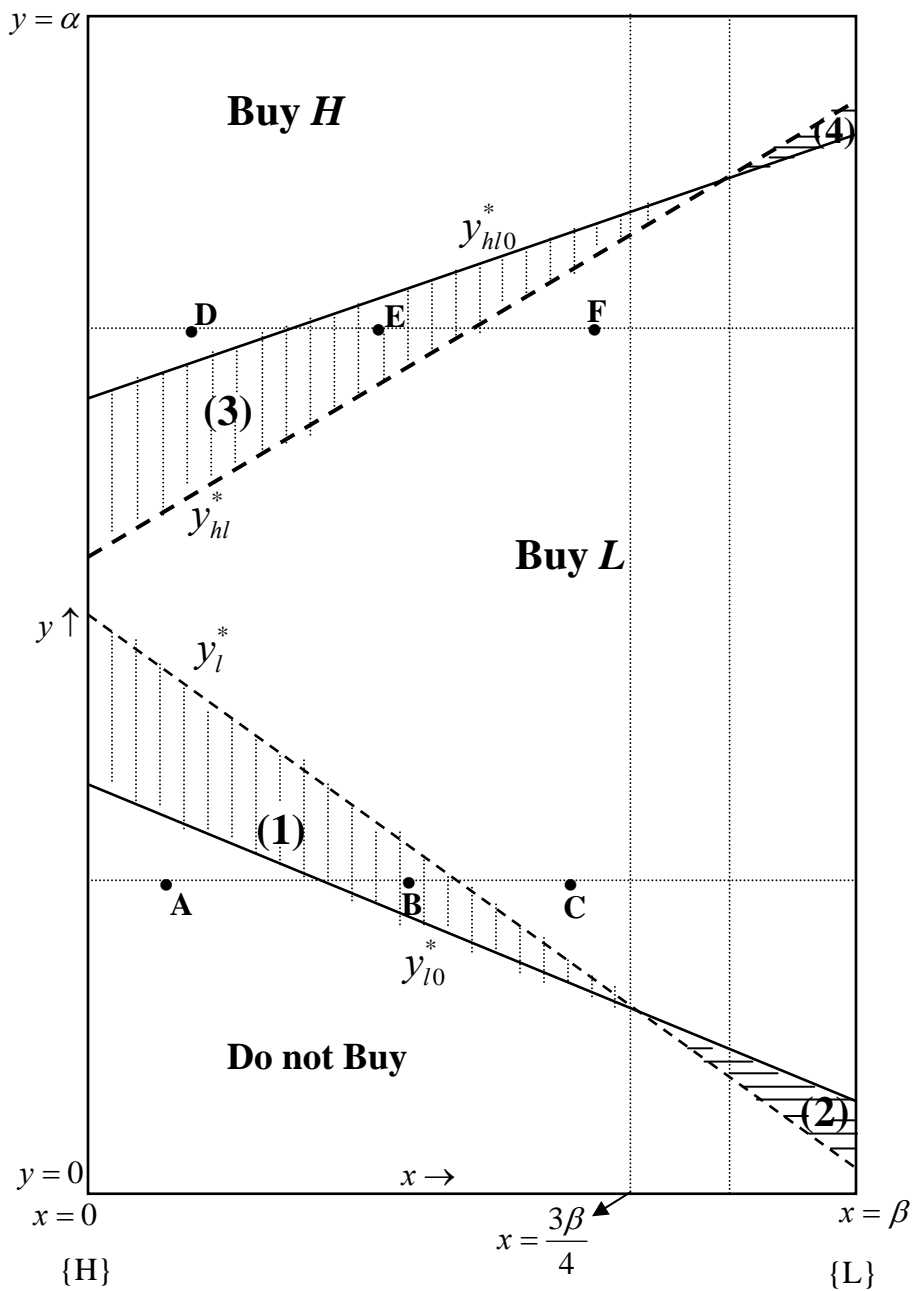
	High Quality Product	Low Quality Product
Prices	$p_{h1}^* = \frac{2q(\alpha + q) - t_{h1}\beta}{4}$	$p_{l1}^* = \frac{2(\alpha + 1) - t_{l1}\beta}{4}$
Margins	$m_{h1}^* = \frac{2q(\alpha - q) - t_{h1}\beta}{4}$	$m_{l1}^* = \frac{2(\alpha - 1) - t_{l1}\beta}{4}$
Sales	$s_{h1}^* = \frac{\beta[2(q-1)(\alpha - q - 1) - (t_{h1} - t_{l1})\beta]}{4(q-1)}$	$s_{l1}^* = \frac{\beta[2q(q-1) + (t_{h1} - t_{l1}q)\beta]}{4(q-1)}$
Profits	$\Pi_{h1}^* = \frac{\beta[2q(\alpha - q) - t_{h1}\beta][2(q-1)(\alpha - q - 1) - (t_{h1} - t_{l1})\beta]}{16(q-1)}$	
	$\Pi_{l1}^* = \frac{\beta[2\alpha - 2 - t_{l1}\beta][q(2q - 2 - t_{l1}\beta) + t_{h1}\beta]}{16(q-1)}$	
Marginal Consumers	$y_{l1}^* = \frac{2\alpha + 2 - t_{l1}\beta}{4} + t_{l1}(\beta - x)$	
	$y_{h1}^* = \frac{2(q-1)\alpha + 2(q^2 - 1) - (t_{h1} + 3t_{l1})\beta + 4(t_{h1} + t_{l1})x}{4(q-1)}$	
Consumer Surplus	$CS_{h1}^* = \frac{\beta}{96(q-1)^2} \left[ 12q(q-1)^2((\alpha - q)^2 - 1) - 12\beta(q-1)(t_{h1}(q-1)\alpha - t_{h1}(q^2 - q - 1) - t_{l1}q) + \beta^2(7(q-2)t_{h1}^2 - 2t_{h1}t_{l1} - 7qt_{l1}^2) \right]$	
	$CS_{l1}^* = \frac{[q(2q - 2 + t_{l1}\beta) + 3t_{h1}\beta]^3 - [q(2q - 2 + 3t_{l1}\beta) - t_{h1}\beta]^3}{384(q-1)^2(t_{h1} + qt_{l1})}$	
	$CS_1^* = \frac{\beta}{96} \left[ 12q((\alpha - q)^2 + q - 1) - 12\beta(t_{h1}(\alpha - q - 1) + t_{l1}q) + \frac{\beta^2(7t_{h1}^2 + 2t_{h1}t_{l1} + 7qt_{l1}^2)}{(q-1)} \right]$	

Table 4: Impact of Bestseller Rank on Discounted List Price,  
 where Discounted List Price = (List Price – Selling Price) / List Price

	Digital Cameras				Upright Vacuums			
	Canon (n=17)		Sony (n=13)		Bissell (n=6)		Hoover (n = 17)	
	Estimate (Standard Error)	<i>t</i>	Estimate (Standard Error)	<i>T</i>	Estimate (Standard Error)	<i>t</i>	Estimate (Standard Error)	<i>t</i>
Intercept	0.1459 (0.0652)	2.24*	0.0319 (0.0354)	0.90	0.2253 (0.0433)	5.20**	0.2408 (0.0576)	4.18***
Bestseller Rank	0.0141 (0.0064)	2.22*	0.01599 (0.0045)	3.59**	0.0351 (0.0111)	3.16*	0.0137 (0.0056)	2.44*
R <sup>2</sup>	0.25		0.54		0.71		0.28	

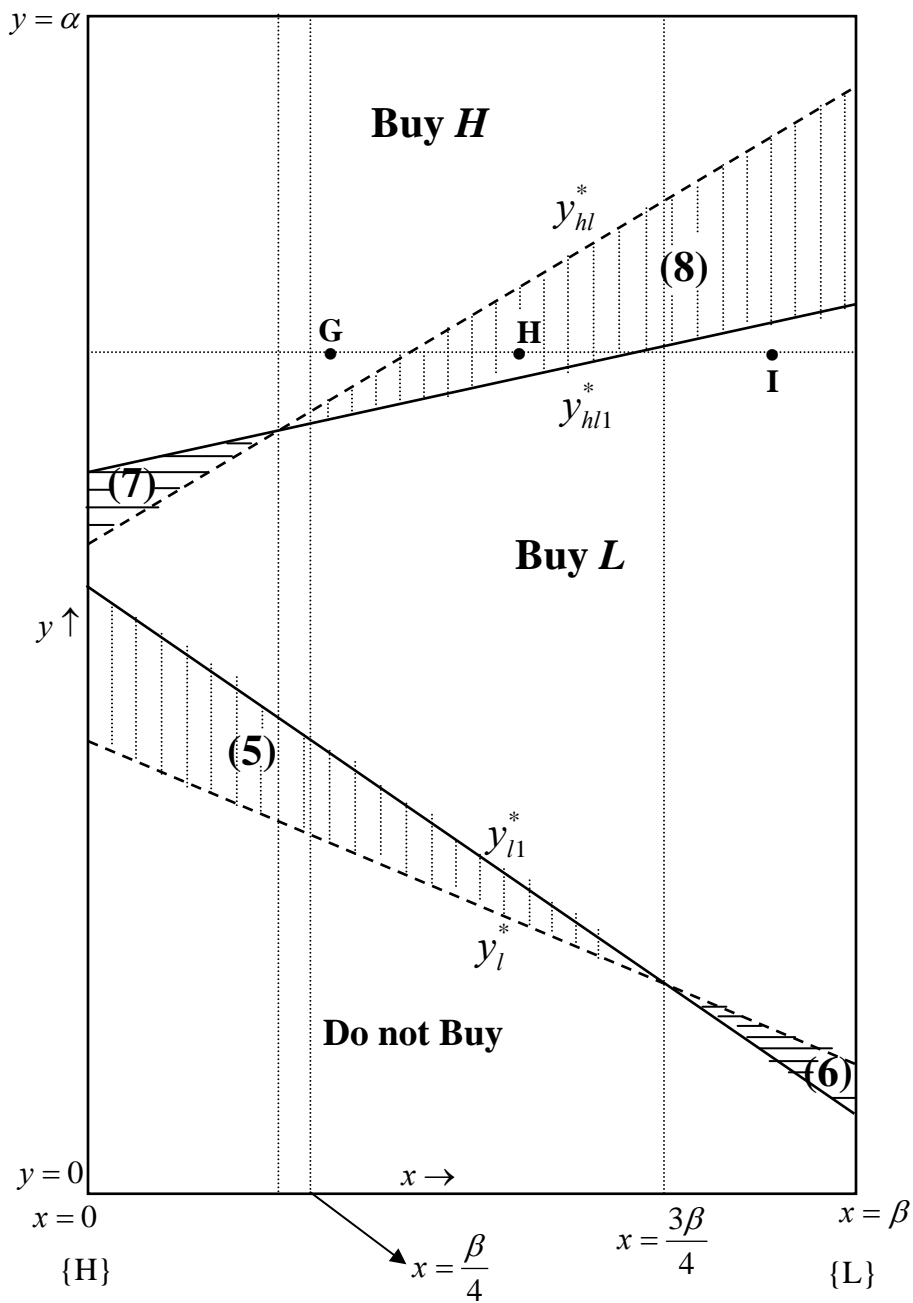
(\* p < 0.05 \*\* p < .01 \*\*\* p < 0.001)

Figure 1: Distribution of consumers when the low quality product  $L$  is announced as bestseller.

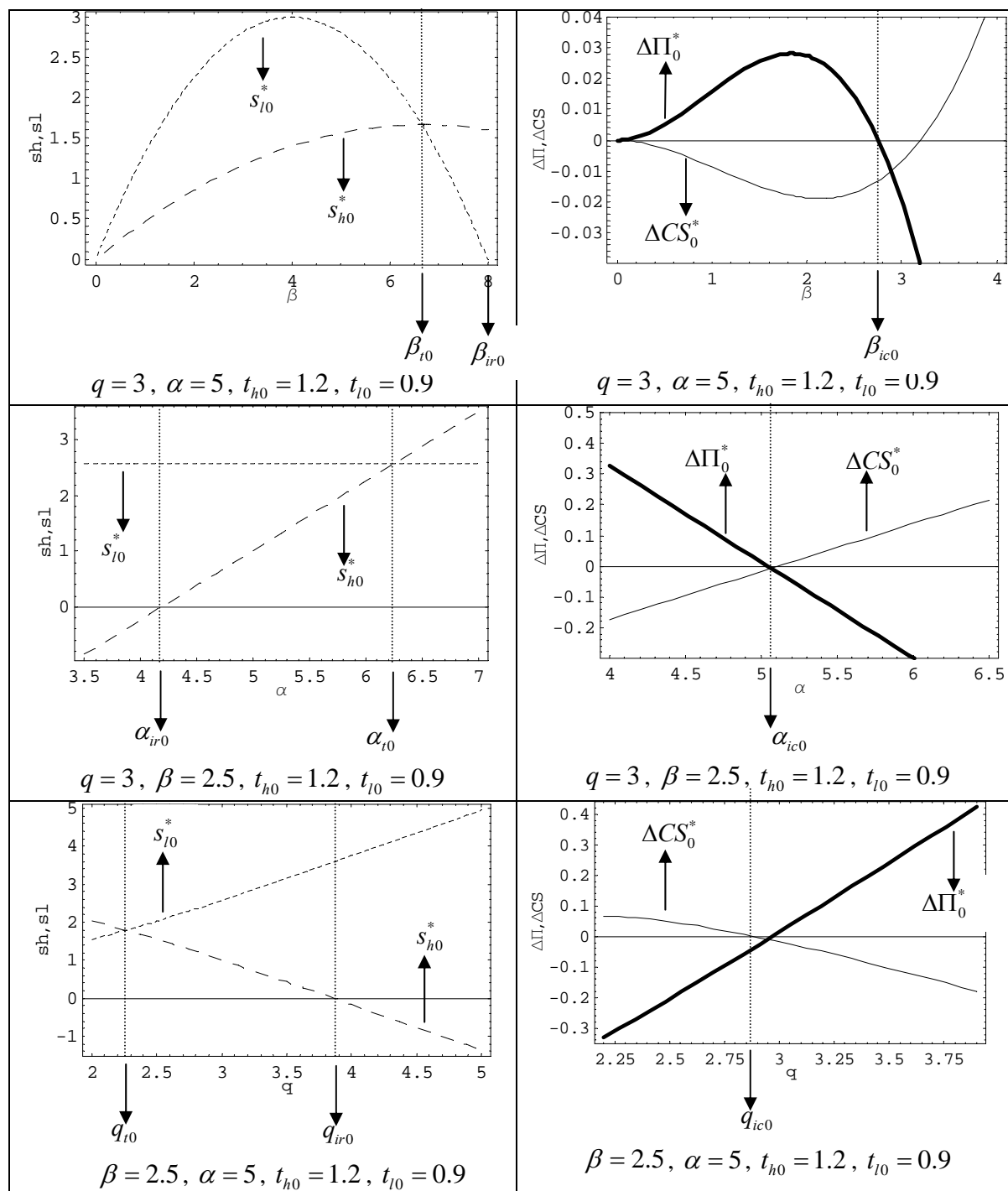


—————	The firm announces $L$ to be the bestseller
- - - - -	The firm does not announce the bestseller.

Figure 2: Distribution of consumers when the high quality product  $H$  is announced as bestseller.

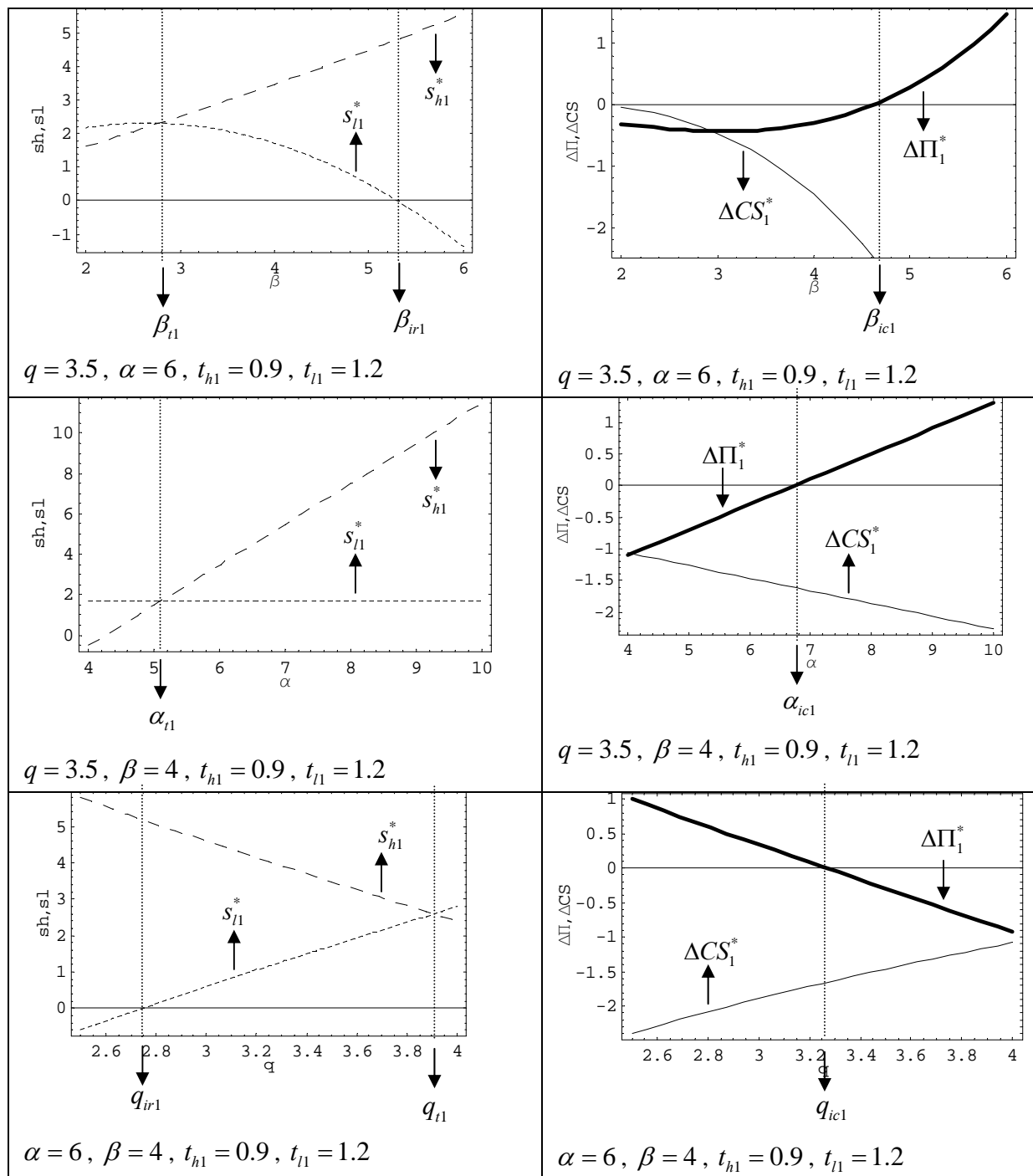


——— The firm announces  $H$  to be the bestseller  
 - - - - - The firm does not announce the bestseller.

Figure 3: Sales; Change in Profit and Consumer Surplus, when  $L$  is revealed as bestseller.

- Sales of  $L$  when  $L$  is revealed to be the bestseller.
- Sales of  $H$  when  $L$  is revealed to be the bestseller.
- Change in profit if  $L$  is revealed to be the bestseller relative to no revelation.
- Relative change in consumer surplus if  $L$  is revealed to be the bestseller

Figure 4: Sales; Change in Profit and Consumer Surplus, when  $H$  is revealed as bestseller.



- - - - - Sales of  $L$  when  $H$  is revealed to be the bestseller.  
 - - - - - Sales of  $H$  when  $H$  is revealed to be the bestseller.  
 ——— Change in profit if  $H$  is revealed to be the bestseller relative to no revelation.  
 ——— Relative change in consumer surplus if  $H$  is revealed to be the bestseller

Figure 5: Market Conditions to Announce when  $L$  is the Bestseller.

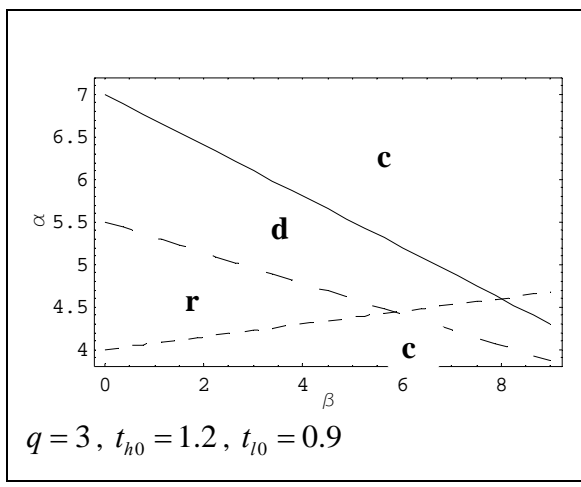
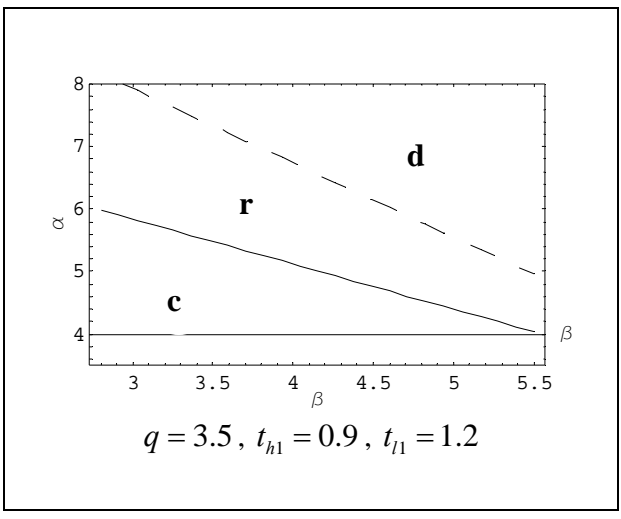


Figure 6: Market Conditions to Announce when  $H$  is the Bestseller.



**c:** Cannot reveal the bestseller  
**d:** Do not reveal the bestseller.  
**r:** Reveal the bestseller.

## Appendix A

A given consumer located at  $(x, y)$  does not consume either product if her utility by doing so is less than 0 (both  $U_h(x, y) < 0$  and  $U_l(x, y) < 0$ ). The consumer purchases the product that provides maximum utility: she purchases product  $H$  if  $U_h(x, y) > U_l(x, y)$  and  $U_h(x, y) > 0$  or she purchases product  $L$  if  $U_l(x, y) > U_h(x, y)$  and  $U_l(x, y) > 0$ . Let  $y_l$  represent the marginal valuation for quality of the consumers indifferent between choosing product  $L$  and not consuming either product. Then  $U_l(x, y_l) = 0$ , or

$$y_l = p_l + t_l(\beta - x) \quad (3)$$

Similarly, let  $y_{hl}$  represent the marginal valuation for quality of the consumers indifferent between purchasing  $H$  and  $L$ . Then  $U_h(x, y_{hl}) = U_l(x, y_{hl})$ , or

$$y_{hl} = \frac{(p_h - p_l) - t_l\beta + (t_h + t_l)x}{q - 1} \quad (4)$$

The discussion above implies that the market is partially covered since consumers who have a marginal valuation for quality within the range  $0 < y < y_l$  do not purchase either product. The consumers who have a marginal valuation for quality within the range  $y_l < y < y_{hl}$  purchase the lower quality product  $L$ . Finally, the remaining consumers, who have a marginal valuation for quality within the range  $y_{hl} < y < \alpha$ , purchase the higher quality product  $H$ . Let  $y_h$  represent the marginal valuation for quality of consumers indifferent between purchasing product  $H$  and not purchasing either product. For these consumers  $U_h(x, y_h) = 0$ , or

$$y_h = \frac{p_h + t_h x}{q} \quad (5)$$

Since the consumers who purchase the higher quality product  $H$  must derive a positive utility from their purchase  $y_{hl} > y_h$ .

We now discuss the sales of the two products. Let  $s_h$  and  $s_l$  represent the sales of products  $H$  and  $L$  respectively.

The sales of product  $H$  are given by  $s_h = \int_0^\beta (\alpha - y_{hl})dx$ , or

$$s_h = \alpha\beta - \frac{\beta(2(p_h - p_l) - (t_h - t_l)\beta)}{2(q - 1)} \quad (6)$$

Similarly, the sales of product  $L$  are given by  $s_l = \int_0^\beta (y_{hl} - y_l)dx$ , or

$$s_l = \frac{\beta(2(p_h - qp_l) + (t_h - qt_l)\beta)}{2(q - 1)} \quad (7)$$

Since the entire market has a size of  $\alpha\beta$ , the number of consumers who do not purchase either one of the two products is given by  $\alpha\beta - s_h - s_l$ .

Following the standard literature, the marginal cost for products  $H$  and  $L$  is a convex function of the level of quality. We assume a simple quadratic cost function,  $c = q^2$ . Then the marginal cost of  $H$  is  $c_h = q^2$  while the marginal cost of  $L$  is  $c_l = 1$ . The margin for product  $H$  is given as  $m_h = (p_h - q^2)$ , while the margin of  $L$  is given as  $m_l = (p_l - 1)$ .

The profit function of product  $H$  is given as  $\Pi_h = m_h s_h$  or

$$\Pi_h = (p_h - q^2) \left( \alpha\beta - \frac{\beta(2(p_h - p_l) - (t_h - t_l)\beta)}{2(q-1)} \right) \quad (8)$$

Similarly, the profit function of product  $L$  is given as  $\Pi_l = m_l s_l$  or

$$\Pi_l = (p_l - 1) \left( \frac{\beta(2(p_h - qp_l) + (t_h - qt_l)\beta)}{2(q-1)} \right) \quad (9)$$

The firm chooses prices that maximize its joint profit from sales of both products  $H$  and  $L$ , given as  $\Pi = \Pi_h + \Pi_l$ , or

$$\Pi = (p_h - q^2) \left( \alpha\beta - \frac{\beta(2(p_h - p_l) - (t_h - t_l)\beta)}{2(q-1)} \right) + (p_l - 1) \left( \frac{\beta(2(p_h - qp_l) + (t_h - qt_l)\beta)}{2(q-1)} \right) \quad (10)$$

We solve this game using backward induction.

Let  $p_h^*$  and  $p_l^*$  represent the equilibrium prices that maximize the firm's aggregate profit. Differentiating the profit function simultaneously yields the following profit-maximizing equilibrium prices:

$$p_h^* = \frac{2q(\alpha + q) - t_h\beta}{4} \quad (11)$$

$$p_l^* = \frac{2(\alpha + 1) - t_l\beta}{4} \quad (12)$$

Note that the second-order conditions are satisfied since  $\frac{\partial^2 \Pi}{\partial p_h^2} = \frac{-2\beta}{(q-1)} < 0$  and  $\frac{\partial^2 \Pi}{\partial p_l^2} = \frac{-2q\beta}{(q-1)} < 0$ .

We examine how the level of heterogeneity in the market impacts the equilibrium prices. From (11) and (12), the equilibrium prices of both products are increasing in the average marginal valuation for quality ( $\alpha$ ). Recall that  $q$  represents the ratio of the quality of the high quality product relative to the low quality product. Observe that the price of the high quality product increases when the quality difference between the two products increases.

In contrast, the prices decrease with increasing heterogeneity in consumers' taste  $\beta$ . To see the intuition, consider any consumer located at  $x$ . This consumer is at a distance  $x$  away from product  $H$  and  $(\beta - x)$  away from the low quality product  $L$  with an expected value  $E[x] = \frac{\beta}{2}$ . An increase in  $\beta$  implies that the consumers' ideal points are, on average, further away from the two products. Consumers then incur larger average transportation costs. The firm has to compensate consumers for incurring these higher transportation costs. Therefore, in equilibrium, the firm lowers prices in response to increasing taste heterogeneity.

Substituting the equilibrium prices into the margins of  $H$  and  $L$  respectively, yields the following equilibrium margins:

$$m_h^* = \frac{2q(\alpha - q) - t_h\beta}{4} \quad (13)$$

$$m_l^* = \frac{2(\alpha - 1) - t_l\beta}{4} \quad (14)$$

Notice that the margins are also increasing in  $\alpha$ , but decreasing in  $\beta$ .

The equilibrium sales are obtained by substituting the equilibrium prices into the expressions for  $s_h$  and  $s_l$ . This yields the following expressions:

$$s_h^* = \frac{\beta[2(q-1)(\alpha-q-1) - (t_h - t_l)\beta]}{4(q-1)} \quad (15)$$

$$s_l^* = \frac{\beta[2q(q-1) + (t_h - t_lq)\beta]}{4(q-1)} \quad (16)$$

We also determine the valuations for quality of the marginal consumers by substituting the equilibrium prices into  $y_l$  and  $y_{hl}$ , yielding

$$y_l^* = \frac{2\alpha + 2 - t_l\beta}{4} + t_l(\beta - x) \quad (17)$$

$$y_{hl}^* = \frac{2(q-1)\alpha + 2(q^2 - 1) - (t_h + 3t_l)\beta + 4(t_h + t_l)x}{4(q-1)} \quad (18)$$

The resulting equilibrium profit made by the retailer from the two products  $H$  and  $L$  are got by substituting the equilibrium margins and sales into the profit functions  $\Pi_h^* = m_h^* s_h^*$  and  $\Pi_l^* = m_l^* s_l^*$ , yielding

$$\Pi_h^* = \frac{\beta[2q(\alpha - q) - t_h\beta][2(q-1)(\alpha - q - 1) - (t_h - t_l)\beta]}{16(q-1)} \quad (19)$$

$$\Pi_l^* = \frac{\beta[2\alpha - 2 - t_l\beta][q(2q - 2 - t_l\beta) + t_h\beta]}{16(q-1)} \quad (20)$$

The equilibrium solution when the bestseller is not announced is summarized in Table 1.

## Appendix B

### Proof of Proposition 1(a)

The firm's decision to reveal or not reveal the lower quality product  $L$  as the bestseller, rests on three constraints: (i) truth-telling, (ii) individual rationality, (iii) incentive compatibility.

First, in order for  $L$  to be the bestseller, the sales of  $L$  should exceed the sales of  $H$ , or  $(s_{h0}^* - s_{l0}^*) < 0$ . The equilibrium sales when  $L$  is announced to be the bestseller (see Table 2) are given by  $s_{h0}^* = \frac{\beta[2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta]}{4(q-1)}$  and  $s_{l0}^* = \frac{\beta[2q(q-1) + (t_{h0} - t_{l0}q)\beta]}{4(q-1)}$ . Substituting in

the inequality  $(s_{h0}^* - s_{l0}^*) < 0$  yields

$\frac{\beta[2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta]}{4(q-1)} - \frac{\beta[2q(q-1) + (t_{h0} - t_{l0}q)\beta]}{4(q-1)} < 0$ . On simplification, this inequality is equivalent to  $2(q-1)(2q+1-\alpha) - \beta((q+1)t_{l0} - 2t_{h0}) > 0$ . This can be rewritten as  $\beta < \beta_{l0}$ , where  $\beta_{l0} = \frac{2(q-1)(\alpha - 2q - 1)}{(2t_{h0} - (q+1)t_{l0})}$ .

Second, individual rationality requires that the sales should be positive. This means that we must have  $s_{h0}^* > 0$  and  $s_{l0}^* > 0$ . Since we already have the condition  $(s_{h0}^* - s_{l0}^*) < 0$ , we only need to check  $s_{h0}^* > 0$ . On substitution, we get  $\frac{\beta[2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta]}{4(q-1)} > 0$ . On simplification,

this inequality is equivalent to  $\beta < \beta_{ir0}$ , where  $\beta_{ir0} = \frac{2(q-1)(\alpha - q - 1)}{(t_{h0} - t_{l0})}$ . Thus, the feasible level of

horizontal differentiation over which the firm decides whether to reveal or not reveal the bestseller occurs when both the above requirements are collectively met, given by  $0 < \beta < \text{Min}\{\beta_{ir0}, \beta_{l0}\}$ . Clearly, the firm cannot reveal the bestseller when  $\beta > \text{Min}\{\beta_{ir0}, \beta_{l0}\}$ .

Third, incentive compatibility requires that the firm's profit after revealing the lower quality product  $L$  to be the bestseller should exceed the profit when it does not reveal the bestseller, or  $\Delta\Pi_0^* = \Pi_0^* - \Pi^* > 0$ .

Table 1 summarizes the profit when the bestseller is not announced. In this case, the firm's profit from selling the two products  $H$  and  $L$  are respectively given by  $\Pi_h^* = \frac{\beta[2q(\alpha - q) - \beta][2(q-1)(\alpha - q - 1)]}{16(q-1)}$  and  $\Pi_l^* = \frac{\beta[2\alpha - 2 - \beta][q(2q - 2 - \beta) + \beta]}{16(q-1)}$ . The

firm's total profit, when it does not announce the bestseller, is got by addition as  $\Pi^* = \Pi_h^* - \Pi_l^*$ .

Table 2 summarizes the profit when  $L$  is announced to be the bestseller. The profit from selling the bestseller  $L$  is  $\Pi_{l0}^* = \frac{\beta[2\alpha - 2 - t_{l0}\beta][q(2q - 2 - t_{l0}\beta) + t_{h0}\beta]}{16(q-1)}$ , while the profit from selling the non-

bestseller  $H$  is  $\Pi_{h0}^* = \frac{\beta[2q(\alpha - q) - t_{h0}\beta][2(q-1)(\alpha - q - 1) - (t_{h0} - t_{l0})\beta]}{16(q-1)}$ . The firm's aggregate

profit is once again got by addition,  $\Pi_0^* = \Pi_{h0}^* - \Pi_{l0}^*$ . The firm finds it profitable to reveal  $L$  as the bestseller when  $\Delta\Pi_0^* = \Pi_0^* - \Pi^* > 0$ . Substituting the above expressions into this inequality and simplifying gives us the constraint

$4(q-1)(t_{h0}(q+1) - t_{l0}q - 1) - 4(q-1)(t_{h0} - 1)\alpha - \beta(q(1-t_{l0}^2) - t_{h0}^2 + 2t_{h0}t_{l0} - 1) > 0$ . This incentive-compatibility condition can be in turn, rewritten as  $0 < \beta < \beta_{ic0}$ , where

$$\beta_{ic0} = \frac{4(q-1)((t_{h0}-1)\alpha + (t_{l0}q+1) - t_{h0}(q+1))}{(t_{h0}^2 - 2t_{h0}t_{l0} + 1 - q(1-t_{l0}^2))}.$$

Thus, the firm profits from announcing  $L$  as the bestseller when  $0 < \beta < \beta_{ic0}$  and does not profit from announcing  $L$  as the bestseller when  $\beta > \beta_{ic0}$ .

The three-step analysis described above collectively proves Proposition 1(a).

The firm reveals (r) the lower quality product  $L$  to be the bestseller when  $0 < \beta < \beta_{ic0}$ .

The firm does not (d) reveal  $L$  to be the bestseller when  $\beta_{ic0} < \beta < \text{Min}\{\beta_{ir0}, \beta_{t0}\}$ .

The firm cannot (c) reveal  $L$  to be the bestseller when  $\beta > \text{Min}\{\beta_{ir0}, \beta_{t0}\}$ , where

$$\begin{aligned}\beta_{ic0} &= \frac{4(q-1)((t_{h0}-1)\alpha + (t_{l0}q+1) - t_{h0}(q+1))}{(t_{h0}^2 - 2t_{h0}t_{l0} + 1 - q(1-t_{l0}^2))} \\ \beta_{ir0} &= \frac{2(q-1)(\alpha - q - 1)}{(t_{h0} - t_{l0})} \\ \beta_{t0} &= \frac{2(q-1)(\alpha - 2q - 1)}{(2t_{h0} - (q+1)t_{l0})}\end{aligned}$$

## Appendix C: Numerical Example

We also conduct numerical simulations to verify the propositions. Figure 3 illustrates Propositions 1(a) to 1(c). Proposition 1(a) states the firm reveals (*r*) the lower quality product *L* to be the bestseller when  $0 < \beta < \beta_{ic0}$ , does not (*d*) reveal *L* to be the bestseller when

$\beta_{ic0} < \beta < \text{Min}\{\beta_{ir0}, \beta_{i0}\}$  and cannot (*c*) reveal *L* to be the bestseller when  $\beta > \text{Min}\{\beta_{ir0}, \beta_{i0}\}$ .

The top left and top right panels in Figure 3 respectively plot the sales and the change in the firm's profits from revealing *L* to be the bestseller. We hold the other model parameters to be constant ( $q = 3$ ,  $\alpha = 5$ ,  $t_{h0} = 1.2$ ,  $t_{l0} = 0.9$ ). The sales plot shows that  $\beta_{i0} = 6.6$  and  $\beta_{ir0} = 8$ , implying that the feasible level of horizontal product differentiation over which the firm either reveals (*r*) or does not reveal (*d*) product *L* to be the bestseller is given by  $(0 < \beta < 6.6)$ . The plot of the change in profit from revealing *L* to be the bestseller, relative to not revealing the bestseller, further shows that  $\beta_{ic0} = 2.8$ , implying that the firm should reveal (*r*) product *L* to be the bestseller when  $(0 < \beta < 2.8)$  and it should not reveal (*d*) when  $(2.8 < \beta < 6.6)$ .

Proposition 1(b) suggests that the firm reveals (*r*) the lower quality product *L* to be the bestseller when  $\alpha_{ir0} < \alpha < \alpha_{ic0}$ , does not (*d*) reveal *L* to be the bestseller when  $\alpha_{ic0} < \alpha < \alpha_{i0}$  and the firm cannot (*c*) reveal *L* to be the bestseller when  $0 < \alpha < \alpha_{ir0}$  and  $\alpha > \alpha_{i0}$ . The middle

panels in Figure 3 plot how the sales and change in profits vary with respect to level  $\alpha$  in the market, holding other model parameters to be constant ( $q = 3$ ,  $\beta = 2.5$ ,  $t_{h0} = 1.2$ ,  $t_{l0} = 0.9$ ).

The sales plot shows that the feasible level of  $\alpha$  over which the firm reveals (*r*) or does not reveal (*d*) product *L* to be the bestseller is given by  $(4.1 < \alpha < 6.2)$ , since  $\alpha_{ir0} = 4.1$  and  $\alpha_{i0} = 6.2$ .

Further,  $\alpha_{ic0} = 5.1$ . Together, the plots indicate that the firm should reveal product *L* to be the bestseller (*r*) when the average marginal valuation for product quality is relatively small  $(4.2 < \alpha < 5.1)$  and not reveal at relatively higher levels of average valuation for product quality  $(5.1 < \alpha < 6.2)$ .

The bottom panels of Figure 3 illustrate Proposition 1(c). We show that the firm reveals (*r*) the lower quality product *L* to be the bestseller when  $q_{ic0} < q < q_{ir0}$ , does not (*d*) reveal *L* to be the bestseller when  $q_{i0} < q < q_{ic0}$  and the firm cannot (*c*) reveal *L* to be the bestseller when,

$1 < q < q_{i0}$  and  $q > q_{ir0}$ . We vary  $q$  holding other model parameters to be constant

$(\alpha = 5, \beta = 2.5, t_{h0} = 1.2, t_{l0} = 0.9)$ . The sales plot shows that the feasible level of  $q$  over which the firm reveals (*r*) or does not reveal (*d*) product *L* to be the bestseller is given by

$(2.2 < q < 3.9)$ , since  $q_{i0} = 2.2$  and  $q_{ir0} = 3.9$ . The plot of the change in profit from revealing *L* to be the bestseller further shows that  $q_{ic0} = 2.95$ . The firm should reveal product *L* to be the

bestseller (*r*) when the quality difference between *H* and *L* is relatively large  $(2.95 < q < 3.9)$  and not when the difference is relatively small  $(2.2 < q < 2.95)$ . Next, we illustrate the case when the high quality product *H* is the bestseller.

Figure 4 illustrates Propositions 2(a) to 2(c). Proposition 2(a) states that the firm reveal (*r*) the higher quality product *H* to be the bestseller when  $\beta_{ic1} < \beta < \beta_{ir1}$ , does not (*d*) reveal *H* to be the bestseller when  $\beta_{i1} < \beta < \beta_{ic1}$  and the firm cannot (*c*) reveal *H* to be the bestseller when  $0 < \beta < \beta_{i1}$  and  $\beta > \beta_{ir1}$ . The top left and top right panels in Figure 4 respectively plot the sales

and profits when the higher-quality product  $H$  is announced to be the bestseller. We hold the other model parameters to be constant ( $q = 3.5$ ,  $\alpha = 6$ ,  $t_{h1} = 0.9$ ,  $t_{l1} = 1.2$ ). The sales plot shows that the feasible level of horizontal product differentiation over which the firm decides whether or not to announce product  $H$  as the bestseller, is given by ( $2.8 < \beta < 5.4$ ) since  $\beta_{t1} = 2.8$  and  $\beta_{ir1} = 5.2$ . The plot of the change in profit from revealing  $H$  to be the bestseller further shows that  $\beta_{ic1} = 4.6$ . Together, the simulation results indicate that the firm should reveal  $H$  to be the bestseller when the level of horizontal product differentiation is relatively large ( $4.6 < \beta < 5.2$ ) and not reveal ( $d$ ) at relatively low levels of horizontal differentiation ( $2.8 < \beta < 4.6$ ).

Proposition 2(b) states that the firm reveals ( $r$ ) the higher quality product  $H$  to be the bestseller when  $\alpha > \alpha_{ic1}$ , does not ( $d$ ) reveal  $H$  to be the bestseller when  $\alpha_{t1} < \alpha < \alpha_{ic1}$  and the firm cannot ( $c$ ) reveal  $H$  to be the bestseller when  $0 < \alpha < \alpha_{t1}$ . The firm's sales and profits when  $\alpha$  varies can be seen in the middle left and middle right panels of Figure 4. The other model parameters are held constant ( $q = 3.5$ ,  $\beta = 4$ ,  $t_{h1} = 0.9$ ,  $t_{l1} = 1.2$ ).  $H$  should be revealed as the bestseller when ( $\alpha > 6.8$ ) since  $\alpha_{ir1} = 3.8$ ,  $\alpha_{t1} = 5.1$  and  $\alpha_{ic1} = 6.8$ . When the average marginal valuation for product quality of consumers is relatively low ( $5.1 < \alpha < 6.8$ ),  $H$  should not be announced as the bestseller.

The bottom panels of Figure 4 illustrate Proposition 2(c). We show that the firm reveals ( $r$ ) the higher quality product  $H$  to be the bestseller when  $q_{ir1} < q < q_{ic1}$ , does not ( $d$ ) reveal  $H$  to be the bestseller when  $q_{ic1} < q < q_{it1}$  and the firm cannot ( $c$ ) reveal  $H$  to be the bestseller when,  $1 < q < q_{ir1}$  and  $q > q_{it1}$ . When the higher-quality product  $H$  is announced to be the bestseller, the bottom panels of Figure 4 plot how the sales and change in profits vary with respect to level of quality difference  $q$  in the market, holding other model parameters to be constant ( $\alpha = 6$ ,  $\beta = 4$ ,  $t_{h1} = 0.9$ ,  $t_{l1} = 1.2$ ). The sales plot shows that the feasible level of  $q$  over which the firm reveals ( $r$ ) or does not reveal ( $d$ ) product  $H$  to be the bestseller is given by ( $2.75 < q < 3.9$ ), since  $q_{ir1} = 2.75$  and  $q_{it1} = 3.9$ . The plot of the change in profit from revealing  $H$  to be the bestseller further shows that  $q_{ic1} = 3.2$ . These plots together indicate that the firm reveals product  $H$  to be the bestseller ( $r$ ) when the quality difference between  $H$  and  $L$  is relatively small ( $2.75 < q < 3.2$ ) and in contrast, the firm does not reveal product  $H$  as the bestseller ( $d$ ) when the level of quality difference between the higher and lower quality products is relatively large ( $3.2 < q < 3.9$ ).