Supplemental Appendix for

Channel Bargaining with Retailer Asymmetry

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In this supplemental appendix we provide supporting analysis omitted from the main text. In section S.1, we present a full analysis of the model with one manufacturer and two competing retailers. In section S.2, we provide a full discussion of the main model with asymmetric bargaining powers. Section S.3 discusses the implications of relaxing the assumption that retailers choose prices simultaneous with the negotiations. Section S.4 provides the formal details omitted from section 5. Finally, details of the numerical calculations are listed in section S.5.

S.1 One Manufacturer and Two Retailers

In this section, we offer a model with one manufacturer and two competing retailers in order to illustrate that the central bargaining outcome from Proposition 1 is robust to a modified channel structure. Specifically, we show that in a model with a single manufacturer, equilibrium wholesale prices favor the low-cost retailer. This one-by-two model is otherwise similar to the two-by-two model of section 3 and, consequently, we omit here many of the supporting details such as the justification of assumptions, intuition and interpretations since they are consistent with that provided in the main text.

Suppose there are two retailers, *W* and *K*, who compete on a single good. Retailers may negotiate bilaterally with manufacturer *M* over the wholesale price of this good or may choose to acquire the same good from some alternative source at a fixed unit price of $\tilde{p}$, which is known and exogenously specified. This alternative source can be interpreted as a more distant or less preferred manufacturer. From a modeling perspective, this alternative provides an outside option for each retailers when negotiating wholesale prices with the manufacturer *M*. Figure S.1 depicts this transactional relationship. Finally, the manufacturer has zero marginal cost of production and retailers face marginal costs $c^K \geq c^W \geq 0$.

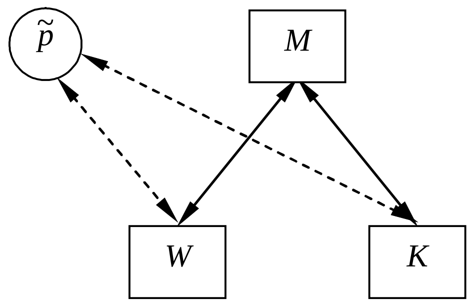

Figure S.1

Because we are interested in capturing the effect of the change in channel structure (from the 1×2 case to the 2×2 case) we maintain the two stage timing as described in the main model in section 3. Specifically, in stage 1 retailers bilaterally negotiate with the manufacturer over wholesale prices p^W and p^K, which are modeled as Nash bargaining. As in the main model, these two negotiation processes are simultaneous and their outcomes are not observed by the outside party. In stage 2, retailers *W* and *K* announce retail prices r^W and r^K, respectively. Note that, as in the main model, we assume that negotiating parties in stage 1 take retail prices as fixed. Consumers observe retail prices and then, after stage 2, decide on one of the two retailers and purchase the product.

Consumers have differentiated preferences over the two retailers, which we represent by locations on the interval [0,1] and the parameter t_r, as in the main text. In contrast to the original model, however, there is only one product and, consequently, a consumer has only one decision, which is the choice between the two retailers. This choice depends only on retail prices and t_r.

Recall that in our modeling of the bargaining process between the manufacturer and retailer *j* to determine the negotiated wholesale price p^j it is necessary to specify stage 2 outcomes in exactly two states of the world: when both negotiations result in agreement and when one of the negotiations results in disagreement. Let r^j, $j = W, K$ denote the retail price when negotiations result in agreement. Similarly, let $\tilde{r}^j$ denote the retail price when negotiations result in disagreement. In the disagreement case, retailer *j* is supplied by the alternative supplier. Then it is routine to show that the agreement and disagreement demands for retailer j are, respectively,

$$D^j = \frac{1}{2} - \frac{r^j - r^l}{2t_r}, \qquad \text{and} \qquad \tilde{D}^j = \frac{1}{2} - \frac{\tilde{r}^j - r^l}{2t_r},$$

where $j = W, K$, and $l \neq j$. It follows that agreement and disagreement payoffs to the retailer are

$$\Pi_j = (r^j - p^j - c^j)\left(\frac{1}{2} - \frac{r^j - r^l}{2t_r}\right), \tag{S.1}$$

and

$$\tilde{\Pi}_j = (\tilde{r}^j - \tilde{p} - c^j)\left(\frac{1}{2} - \frac{\tilde{r}^j - r^l}{2t_r}\right), \tag{S.2}$$

where $j = W, K$, and $l \neq j$. Assuming retail prices r^j and $\tilde{r}^j$ are chosen optimally with respect to (S.1) and (S.2), respectively, then it can be directly shown that

$$r^j = t_r + \tfrac{2}{3}(p^j + c^j) + \tfrac{1}{3}(p^l + c^l) \tag{S.3}$$

and

$$\tilde{r}^j = r^j + \frac{\tilde{p} - p^j}{2}, \tag{S.4}$$

where $j = W, K$, $l \neq j$. Note from (S.4) that retailer *j*, when supplied by the alternative supplier, charges a higher retail price than when supplied by the manufacturer *M* whenever $\tilde{p} > p^j$, which must be the case in an agreement equilibrium.

The manufacturer's agreement and disagreement payoffs are, respectively,

$$V = p^W D^W + p^K D^K = p^W\left(\frac{1}{2} - \frac{r^W - r^K}{2t_r}\right) + p^W\left(\frac{1}{2} + \frac{r^W - r^K}{2t_r}\right), \tag{S.5}$$

and

$$\tilde{V}^{-j} = p^l\left(\frac{1}{2} + \frac{\tilde{r}^j - r^l}{2t_r}\right). \tag{S.6}$$

The Nash bargaining solution implies the following conditions for equilibrium wholesale prices:

$$\overline{p}^{W} = \arg\max_{p^W} (\Pi^{W} - \widetilde{\Pi}^{W})(V - V^{-W}) \tag{S.7}$$

$$\overline{p}^{K} = \arg\max_{p^K} (\Pi^{K} - \widetilde{\Pi}^{K})(V - V^{-K}), \tag{S.8}$$

which assumes that bargaining powers are equal within the channel (i.e. $\alpha = ½$). Our desired result is shown in the following proposition.

Proposition S.1

In the one manufacturer × two retailer model presented above, with $\Delta_c = c^K - c^W > 0$,

$$\text{if} \quad \widetilde{p} \le 4\left(t_r + \frac{\Delta_c}{3}\right), \text{ then } \quad \overline{p}^{K} = \overline{p}^{W} \quad \text{and}$$

$$\text{if} \quad \widetilde{p} > 4\left(t_r + \frac{\Delta_c}{3}\right), \text{ then } \quad \overline{p}^{K} > \overline{p}^{W}.$$

Proof

The objectives in (S.7) and (S.8) have first order derivatives expressed by the following:

$$\begin{aligned} F^{W}(p^{W}, p^{K}) &\equiv \frac{\partial(\Pi^{W} - \widetilde{\Pi}^{W})(V - \widetilde{V}^{-W})}{\partial p^{W}} \\ &= \left(\frac{\widetilde{p} - p^{W}}{4t_r}\right)(t_r + r^K - c^W - \widetilde{p} + p^K) - p^W\left(\frac{1}{2} + \frac{r^K - r^W}{2t_r}\right) \\ &= \left(\frac{\widetilde{p} - p^{W}}{4t_r}\right)\left[2t_r + \tfrac{2}{3}(p^K + c^K) + \tfrac{1}{3}(p^W + c^W) - (\widetilde{p} + c^W - p^K)\right] \\ &\qquad - \frac{p^W}{4t_r}\left[2t_r + \tfrac{2}{3}((p^K + c^K) - (p^W + c^W))\right] \end{aligned} \tag{S.9}$$

and

$$F^K(p^W,p^K)\equiv\frac{\partial(\Pi^K-\tilde{\Pi}^K)(V-\tilde{V}^{-K})}{\partial p^K}$$
$$=\left(\frac{\tilde{p}-p^K}{4t_r}\right)(t_r+r^W-c^K-\tilde{p}+p^W)-p^K\left(\frac{1}{2}-\frac{r^K-r^W}{2t_r}\right)$$
$$=\left(\frac{\tilde{p}-p^K}{4t_r}\right)\left[2t_r+\tfrac{2}{3}(p^W+c^W)+\tfrac{1}{3}(p^K+c^K)-(\tilde{p}+c^K-p^W)\right]$$
$$-\frac{p^K}{4t_r}\left[2t_r-\tfrac{2}{3}((p^K+c^K)-(p^W+c^W))\right] \qquad \text{(S.10)}$$

which results from substituting in the retailers' optimization conditions (S.3). It is directly shown that the respective second order derivates are negative for positive demand. Henceforth, we take F^i's to be decreasing in p^i.

The equilibrium pair of wholesale prices $\bar{p}^W$, $\bar{p}^K$ must satisfy $F^W(\bar{p}^W,\bar{p}^K)$ = $F^K(\bar{p}^W,\bar{p}^K)$ = 0. Assume a symmetric equilibrium so that $\bar{p}^W=\bar{p}^K=\bar{p}$. Setting $F^W(\bar{p},\bar{p})=0$ and rearranging terms yields

$$2\bar{p}^2-3\bar{p}\left[\tilde{p}-\tfrac{4}{3}(t_r+\tfrac{\Delta_c}{3})\right]+\tilde{p}\left[\tilde{p}-2(t_r+\tfrac{\Delta_c}{3})\right]=0 \quad .$$

There are two roots to this quadratic equation in $\bar{p}$: $\bar{p}_1=\frac{\tilde{p}}{2}$ and $\bar{p}_2=\tilde{p}-2(t_r+\tfrac{\Delta_c}{3})$.

Only the bigger of the two roots also satisfies the stability condition that $\frac{\partial F^W(\bar{p},\bar{p})}{\partial\bar{p}}<0$.

Hence, the stable symmetric equilibrium that solves $F^W(\bar{p},\bar{p})=0$ is:

$$\bar{p}=\begin{cases}\dfrac{\tilde{p}}{2} & \text{if} \quad \tilde{p}\le 4\left(t_r+\dfrac{\Delta_c}{3}\right)\\[2ex] \tilde{p}-2\left(t_r+\dfrac{\Delta_c}{3}\right) & \text{if} \quad \tilde{p}>4\left(t_r+\dfrac{\Delta_c}{3}\right).\end{cases}$$

Substituting $\bar{p}=\frac{\tilde{p}}{2}$ in (S9) and (S10) yields that $F^W(\bar{p},\bar{p})=F^K(\bar{p},\bar{p})=0$, implying that the negotiations yield the same wholesale price to both retailers. Substituting

$\overline{p} = \tilde{p} - 2\left(t_r + \frac{\Delta_c}{3}\right)$ in (S.10) yields that $F^K(\overline{p}, \overline{p}) = \dfrac{(\tilde{p} - \overline{p})}{4t\left[2t_r + \frac{2\Delta_c}{3}\right]}\left\{\frac{4}{3}\Delta_c(2\overline{p} - \tilde{p})\right\} > 0$,

where the latter inequality follows since $\overline{p} > \frac{\tilde{p}}{2}$ in this case given that $\tilde{p} > 4\left(t_r + \frac{\Delta_c}{3}\right)$.

Given the existence of an interior equilibrium, this inequality implies that $p^K > p^W$.

Q.E.D.

Note that the result reported in Proposition S.1 is weaker than the one we obtain in the 2x2 case, considered in the main text. Specifically, only when the outside price $\tilde{p}$ is sufficiently high (i.e. $\tilde{p} > 4\left(t_r + \frac{\Delta_c}{3}\right)$) $p^K > p^W$, otherwise the two retailers face the same wholesale prices. However, as in the main text, it is never the case that the more efficient retailer faces higher wholesale prices.

S.2 Asymmetric Bargaining Powers

In the analysis of the main text, it is assumed that bargaining powers are equal and symmetric across retailers ($\alpha_K = \alpha_W$). Here, we briefly discuss the consequences of relaxing this condition.

First, we define the Nash solution to the generalized bargaining problem as, $\overline{p}^j = \arg\max(\Pi_j - \Pi_j^{-i})^{1-\alpha_j}(V_i - V_i^{-j})^{\alpha_j}$, $j = W, K$, where the exponent $\alpha_j \in (0,1)$ denotes the bargaining power of the manufacturer in negotiations with retailer j. First order conditions for this maximization problem yield the following conditions, which are analogous to (A.1) and (A.2), respectively:

$$\frac{t}{2}\left(t_r + \frac{\Delta_c}{3} + \frac{\overline{p}^K - \overline{p}^W}{3} - \frac{t}{16}\right) - \left[\overline{p}^W\left(t_r + \frac{\Delta_c}{3} + \frac{\overline{p}^K - \overline{p}^W}{3}\right) - \frac{t}{8}\overline{p}^K\right]\left(\frac{1-\alpha_W}{\alpha_W}\right) = 0$$

$$\frac{t}{2}\left(t_r - \frac{\Delta_c}{3} - \frac{\overline{p}^K - \overline{p}^W}{3} - \frac{t}{16}\right) - \left[\overline{p}^K\left(t_r - \frac{\Delta_c}{3} - \frac{\overline{p}^K - \overline{p}^W}{3}\right) - \frac{t}{8}\overline{p}^W\right]\left(\frac{1-\alpha_K}{\alpha_K}\right) = 0.$$

Numerical calculations suggest that our main results of sections 3 and 4 hold for bargaining powers in a neighborhood of $(\alpha_K, \alpha_W) = (\frac{1}{2}, \frac{1}{2})$. However, we illustrate examples of how these results can be overturned with perverse values of the bargaining power parameters. In the Table S1, we provide a case when Proposition 1 is overturned and another when manufacturer profits *decrease* with respect to Δ_c.

The results indicated in Proposition 1 can be overturned when retailer *K*'s bargaining power vis-à-vis the retailer is sufficiently stronger than retailer *W*'s ($\alpha_K << \alpha_W$). Retailer *W*'s advantage in terms of bargaining position, as a result of its cost advantage $\Delta_c > 0$, is offset by retailer K's advantage in bargaining power. Hence, in negotiations the high cost retailer secures a more favorable wholesale price, $p^K < p^W$, as indicated in the first part of Table S1.

Δ_c	p^W	p^K	r^W	r^K	V_i
$\alpha_K = 0.3 \quad \alpha_W = 0.7$					
0.5	0.806	0.367	3.326	3.347	0.2956
1.0	0.854	0.407	3.039	3.223	0.3360
$\alpha_K = 0.7 \quad \alpha_W = 0.3$					
0.5	0.313	0.697	3.108	3.402	0.2243
1.0	0.293	0.629	2.738	3.184	0.1930

Table S1 Specialized Cases with Asymmetric Bargaining Powers
($t = t_r = 1$)

The result from section 4 stating that manufacturer profits are increasing in Δ_c can also be overturned when $\alpha_K >> \alpha_W$. In this case, retailer *K*'s bargaining power with the manufacturer is so weak, relative to *W*'s, that it is significantly disadvantaged in retail competition. The unfavorable wholesale price to *K* leads to highly asymmetric market shares, in favor of retailer *W*. The manufacturer's bargaining position, as measured by the disagreement payoff, V_i^{-W}, is sufficiently harmed as a result. So much in fact, that it is unable to capture any efficiency gains from the advantaged retailer. This is indicated in Table S1 by the fact that V_i is decreasing in Δ_c.

S.3 Retail Pricing Sequential to Negotiations

In the main text, it was assumed that retailers' pricing decisions are fixed in negotiations between a manufacturer and a retailer since each retailer cannot observe the outcome of the negotiations of its competitor. In this section, we illustrate the relevance of this assumption and then argue that it makes sense for our multi-product retailer setting.

In order to see that this assumption has non-trivial consequences, reconsider the model of section 2. Recall that the choice of wholesale price was chosen in negotiations solely to split the channel surplus between the two channel members. See equation (1). That is, the bargaining process did nothing to affect the overall potential surplus of the channel.

Now suppose, in contrast, that retail price is chosen subsequent to negotiations so that the wholesale pricing decision affects the final retail price and, thus, the total channel surplus. In this modified setting, retail price is expressed as a function of wholesale price p:

$$r^*(p) = \tfrac{1}{2}(1 + p + c) = \arg\max_r (r - p - c)D(r),$$

where $D(r) = 1 - r$ as in Section 2. Then, for a given wholesale price p the retailer earns an agreement payoff of

$$\Pi(p) = \tfrac{1}{4}(1 - p - c)^2.$$

The manufacturer an agreement payoff of

$$V(p) = pD(r^*(p)) = \tfrac{p}{2}(1 - p - c).$$

The distinction here is that realized demand $D(r^*(p))$ is considered in the negotiations between the manufacturer and retailer. Assuming disagreement payoffs $\tilde{\Pi} = \tilde{V} = 0$, the Nash bargaining solution leads to the wholesale price

$$p^+ = \tfrac{1}{4}(1 - c) = \arg\max_p \Pi(p)V(p),$$

which is lower than the wholesale price $p^* = \tfrac{1}{3}(1 - c)$ derived in Section 2. The reason is that the negotiations in the present context consider more factors when optimizing – namely realized demand. Hence, negotiations yield a more coordinated channel through a lower wholesale price. As one might expect, retailer profits increase as a result:

$$\Pi(p^+) = \tfrac{9}{64}(1 - c)^2 > \tfrac{1}{9}(1 - c)^2.$$

The manufacturer's overall profit, on the other hand, decreases as result of this modification:

$$V(p^{+}) = \tfrac{3}{32}(1-c)^2 < \tfrac{1}{9}(1-c)^2, \tag{S.11}$$

despite the fact that overall channel profits have increased from $\tfrac{2}{9}(1-c)^2$ to $\tfrac{15}{64}(1-c)^2$.

Note from (S.11) that a reduction in retail costs improves manufacturer profits since $dV/dc > 0$. Hence, the main result that manufacturer profits increase as a result of retailer efficiency improvements holds when retail price is set subsequent to bargaining.

The retailer in the above model and of section 2 of the main text carries one product and, as a result, negotiates with only one manufacturer. Thus, implementing sequential retail pricing creates little analytical difficulties (as the above analysis illustrates.) However, ambiguities arise with sequential retail pricing when modeling retailers who carry multiple products. In particular, when the wholesale price over which a retailer and a manufacturer negotiate affects retailer prices of *other* manufacturers' products, it is ambiguous how one specifies the bargaining objective with respect to the retail prices of other products sold at this retailer.

To see this, note that an important feature of retailers who carry multiple manufacturers' products is their ability to internalize cross-price effects across competing products. For example, a single agent choosing prices for competing products will set them higher than two independent agents would. This can be seen in the retailer's first order conditions written in equation (5). Note that the last term $\partial D_l^j / \partial r_i^j$, which is positive, captures the effect that raising the price of manufacturer *i*'s product raises the demand of manufacturer *l*'s. Moreover, *both* wholesale prices p_i^j and p_l^j influence this effect. Consequently, if the retail prices were chosen subsequent to negotiations, then it becomes arbitrary how one allocates this effect across two independent bargaining processes.

To be sure, our imposition that negotiations be bilateral and simultaneous creates this complication. However, these two features are the most natural, given our research objectives. Specifically, the bilateral feature ensures that there are no chances to explicitly collude. Any bargaining that permits more than two agents, for example, includes either two manufacturers or two retailers, which is certainly not a commonly observed phenomenon given legal constraints. The simultaneous aspect of the bargaining model maintains symmetry across manufacturers, allowing us to focus uniquely on retailer asymmetry. In particular, if bargaining were sequential, then one manufacturer would have the advantage of observing the outcome of the previous negotiations. This is beyond the focus of the present work.

To summarize, given that it is desirable to model negotiations as bilateral and simultaneous, then the bargaining processes for multi-product retailers must have independent objectives. Allowing for sequential retail prices requires the modeler to divide up the agency of the retailer across multiple bargaining processes, which in turn, would require more limiting restrictions on the model.

S.4 When Consumers are Informed of Product Preferences

The basic model discussed in sections 3 and 4 assumes that consumers are *a priori* uninformed about their product preferences and must visit a retailer to know their location in product space. In this section we compare that case to the case in which consumers know their product preferences before making their retailer choice. This distinction has an important implication with regard to the distribution of surpluses

Recall from section 3, some consumers buy the brand they prefer least, *ex post*, net of price whenever the retailer they visit carries only one brand. However, if informed, a consumer would visit the retailer who carries her preferred brand. Thus, in a setting with informed consumers, a manufacturer who sells to only one retailer obtains a higher demand for its product than when consumers are uninformed, all else equal. And even though this outcome never occurs in equilibrium, the payoffs determined in this outcome affect the bargaining positions of the negotiating parties. In particular, since consumer information raises demand for the manufacturer selling through only one channel, the manufacturer's bargaining position is improved, relative to the uninformed case. Consequently, a larger share of the channel surplus accrues to the manufacturer.

This last point illustrates an incentive for the manufacturer to advertise directly to consumers. For example, a manufacturer who informs consumers about product attributes in order to help them learn their preferences over products, can improve its negotiating position vis-à-vis retailers. We formalize this intuition by illustrating that when consumers are informed of their location in product space, manufacturer profits increase.

S.4.1 Model with Informed Consumers

Reconsider the game from section 3 in which consumers know their location y before making their retailer choice. The remainder of the game is as in the original model. Bilateral negotiations between manufacturer and retailer over wholesale price occur in stage 1. Retailers set retail prices in stage 2 followed by consumers' retail store choices and product choices.

We maintain the assumption from section 2 that all consumers are also informed about prices and product availability at each retail store. As a result, a consumer's store choice involves no uncertainty since she knows what product she will buy before visiting the retailer. Formally, the consumer located at (x, y) facing retail prices r_i^j, $i = 1,2$ and $j = W, K$, chooses a retailer j and product i to maximize utility:

$$U(i,j) = \begin{cases} v_p - t_r x - ty - r_1^W & i = 1,\ j = W \\ v_p - t_r x - t(1-y) - r_2^W & i = 2,\ j = W \\ v_p - t_r(1-x) - ty - r_1^K & i = 1,\ j = K \\ v_p - t_r(1-x) - t(1-y) - r_2^K & i = 2,\ j = K. \end{cases}$$

Note that if stage 1 negotiations between retailer j and manufacturer i end in disagreement, then set $r_i^j = \infty$.

The main analytical distinction between the informed case and the uninformed case of section 3 is in determining market shares to each retailer and manufacturer. Moreover, it is the difference in market share between the two cases that is central to the main result. We focus, therefore, on the market share analysis and relegate to a later proof the remaining details, which follow the same analytical logic as the uniformed case of section 3.

Market shares to each retailer and manufacturer are defined by areas in a partition of the unit cube, $[0,1]^2$, specified by a system of inequalities formed from the consumer's maximization problem. Of the many possible partitions allowable by the loosest restrictions on the parameter space, we focus only on a special class of partitions in which manufacturers earn higher profits in this modified game. In particular, we consider outcomes that have positive market shares for both retailers and both products when all negotiations result in agreement. (See Figure S2.) We also restrict attention to the case when retailers are sufficiently differentiated relative to products. Specifically, we replace assumption A2 with a stronger assumption:

A2' $t_r / t > 7/8$.

This assumption is sufficient to guarantee that all consumers “located” at the retailers location will shop at that retailer even when it carries only one product.[1]

To illustrate the distribution of market shares when both retailers carry both products, suppose that $r_2^W - r_1^W \geq r_2^K - r_1^K$ and let x_i^* denote the location of a consumer indifferent between buying product i from retailers W and K. Under this condition, retailer W is more attractive to consumers who prefer product 1 and retailer K to those who prefer product 2. Because consumers know their location y before visiting the retailer, they visit the store that offers a better value for their preferred brand. Figure S2 illustrates this by the fact that $x_1^* > x_2^*$. This effect is not present in the uninformed case in which a consumer’s store decision is based only on *expected* utility of product consumption over all possible values of y. In the context of Figure 7, with uninformed consumers yields $x_1^* = x_2^*$.

Despite this distinction in market shares, the marginal changes in market share with respect to retail price r_i^j remain unchanged with informed consumers. Given wholesale prices p_i^j, $i = 1,2$ and $j = W, K$, the optimal retail pricing rules is given by (5). Consequently, the agreement payoffs in the informed case, denoted $\hat{\Pi}_j$ and $\hat{V}_i$, remain expressed by equations (9) and (11). As a result, if product information causes any difference in negotiated wholesale prices, then it must be reflected in the disagreement payoffs.

Now consider the market shares when a retailer, say *W*, and a manufacturer, say 2, fail to reach an agreement in stage 2 negotiations. In the uninformed case, there is a set of consumers who visit retailer W but would have been better off, *ex post*, shopping at retailer K. With product information, however, these consumers always make the best

[1] It is not claimed that this assumption is necessary for our result.

decision ex post. This set of consumers is represented in Figure S3 by the triangular region defined by points *ABC*.

Compared to the uninformed case, manufacturer 2's disagreement position is improved since product information has caused this set of consumers to switch stores in order to obtain its product. As a result, its negotiating position vis-à-vis retailer *W* is improved, leading to a share of the channel surplus in the form of higher negotiated wholesale price.

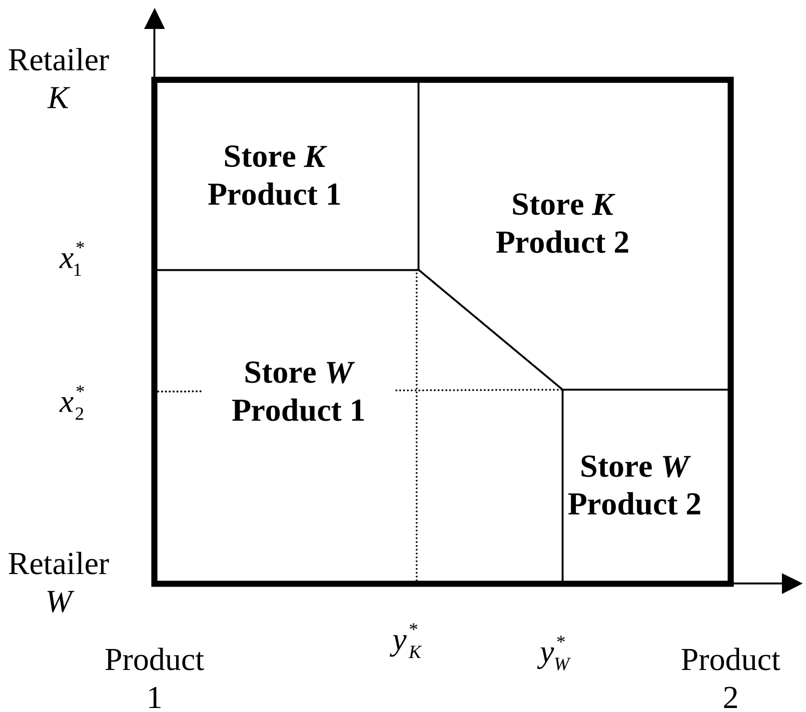

Figure S2: Market Shares when $r_2^W - r_1^W \geq r_2^K - r_1^K$

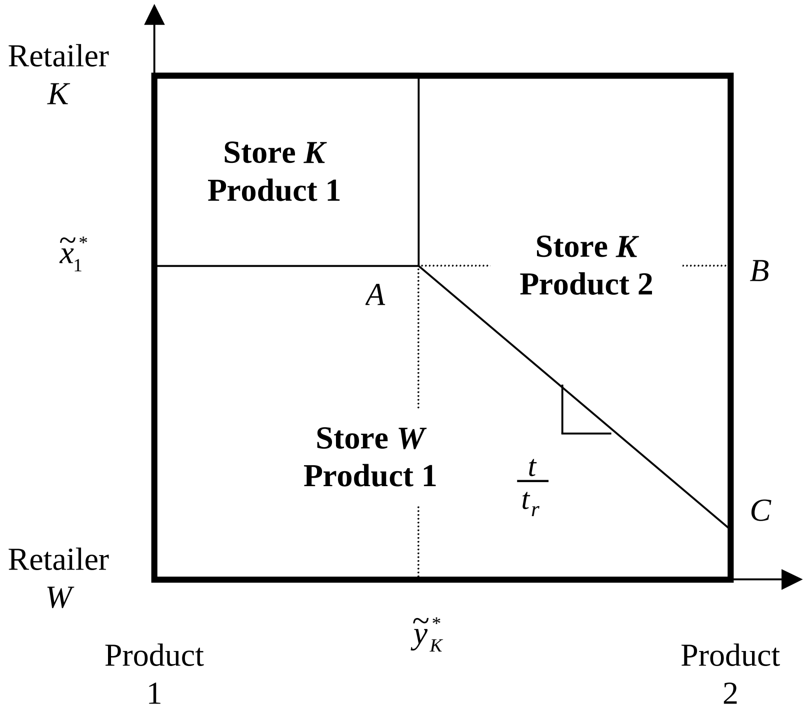

Figure S3: Market Shares when Retailer *W* Carries only Product 1

Furthermore, as in the basic model, there exists a second order strategic effect that works to further increase wholesale prices beyond the first order effect of the improved bargaining position. In particular, each retailer faces higher wholesale prices, which induces it to raise its price. Consequently, each retailer strategically reacts to its rival's price increase by raising its price further. (Recall the discussion in section 4.) As a result, there is additional extraction of consumer surplus to which the manufacturers receive a portion through the negotiations. These two effects are combined and generalized in the following proposition, where $\hat{p}^j$ denotes the equilibrium wholesale prices in the equilibrium with informed consumers.

Proposition S2

Under Assumption A2', $\hat{p}^j > \overline{p}^j$ for $j = W, K$.

In order to prove Proposition S2, we state and prove a lemma, which characterizes the demand of each product at each retailer when consumers are informed of the location y in product space.

Lemma S1

Assume consumers are informed of their location y .

(i) If retailers *W* and *K* carry both brands and $r_2^W - r_1^W \geq r_2^K - r_1^K$. Then product demands are given by

$$D_1^W = \left(\frac{1}{2} + \frac{r_2^K - r_1^K}{2t}\right)\left(\frac{1}{2} + \frac{r_1^K - r_1^W}{2t_r}\right) + \left[\frac{r_2^W - r_1^W}{2t} - \frac{r_2^K - r_1^K}{2t}\right]\left[\frac{1}{2} + \frac{(r_1^K + r_2^K) - (r_1^W + r_2^W)}{4t_r}\right]$$

$$D_2^W = \left(\frac{1}{2} + \frac{r_1^W - r_2^W}{2t}\right)\left(\frac{1}{2} + \frac{r_2^K - r_2^W}{2t_r}\right)$$

$$D_1^K = \left(\frac{1}{2} + \frac{r_2^K - r_1^K}{2t}\right)\left(\frac{1}{2} + \frac{r_1^W - r_1^K}{2t_r}\right)$$

$$D_2^K = \left(\frac{1}{2} + \frac{r_1^W - r_2^W}{2t}\right)\left(\frac{1}{2} + \frac{r_2^W - r_2^K}{2t_r}\right) + \left[\frac{r_2^W - r_1^W}{2t} - \frac{r_2^K - r_1^K}{2t}\right]\left[\frac{1}{2} + \frac{(r_1^W + r_2^W) - (r_1^K + r_2^K)}{4t_r}\right].$$

(ii) If retailers *W* and *K* carry both brands and $r_2^W - r_1^W < r_2^K - r_1^K$. Then product demands are given by

$$D_1^W = \left(\frac{1}{2} + \frac{r_2^W - r_1^W}{2t}\right)\left(\frac{1}{2} + \frac{r_1^K - r_1^W}{2t_r}\right)$$

$$D_2^W = \left(\frac{1}{2} + \frac{r_1^K - r_2^K}{2t}\right)\left(\frac{1}{2} + \frac{r_2^K - r_2^W}{2t_r}\right) + \left[\frac{r_2^K - r_1^K}{2t} - \frac{r_2^W - r_1^W}{2t}\right]\left[\frac{1}{2} + \frac{(r_1^K + r_2^K) - (r_1^W + r_2^W)}{4t_r}\right]$$

$$D_1^K = \left(\frac{1}{2} + \frac{r_2^W - r_1^W}{2t}\right)\left(\frac{1}{2} + \frac{r_1^W - r_1^K}{2t_r}\right) + \left[\frac{r_2^K - r_1^K}{2t} - \frac{r_2^W - r_1^W}{2t}\right]\left[\frac{1}{2} + \frac{(r_1^W + r_2^W) - (r_1^K + r_2^K)}{4t_r}\right].$$

$$D_2^K = \left(\frac{1}{2} + \frac{r_1^K - r_2^K}{2t}\right)\left(\frac{1}{2} + \frac{r_2^W - r_2^K}{2t_r}\right)$$

(iii)Under Assumption A2', if retailer *W* carries only brand 1 and charges price $\tilde{r}^W$, and retailer *K* carries both brands and charges r_1^K and $r_2^K - \tilde{r}^W > \frac{1}{8}$, then product demands at retailer *W* are

$$\tilde{D}_1^W = \left(\frac{1}{2}+\frac{r_1^K-\tilde{r}^W}{2t_r}\right)\left(\frac{1}{2}+\frac{r_2^K-r_1^K}{2t}\right)+\left(\frac{1}{2}+\frac{r_1^K+r_2^K-2\tilde{r}^W}{4t_r}-\frac{t}{4t_r}\right)\left(\frac{1}{2}+\frac{r_1^K-r_2^K}{2t}\right);$$

$$\tilde{D}_2^W = 0; \qquad \tilde{D}_1^K = \left(\frac{1}{2}+\frac{r_2^K-r_1^K}{2t}\right)\left(\frac{1}{2}+\frac{\tilde{r}_1^W-r_1^K}{2t_r}\right); \qquad \tilde{D}_2^K = 1-\tilde{D}_1^W-\tilde{D}_1^K.$$

Proof of Lemma S1

(i) Define x_i^* as the location of the a consumer who is indifferent between buying product *i* from retailer *W* or from retailer *K*. Then

$$x_i^* = \frac{1}{2}+\frac{r_i^K-r_i^W}{2t_r}, \qquad i=1,2.$$

Define y_j^* by the location of a consumer indifferent between buying product 1 and product 2 at retailer *j*. Then

$$y_j^* = \frac{1}{2}+\frac{r_2^j-r_1^j}{2t}, \qquad j=W,K.$$

If $r_2^W-r_1^W=r_2^K-r_1^K$ then product demands are $x_1^*y_W^*$, $(1-x_1^*)y_W^*$, $x_1^*(1-y_W^*)$, $(1-x_1^*)(1-y_W^*)$, respectively. Otherwise, $r_2^W-r_1^W>r_2^K-r_1^K$ implies $x_1^*>x_2^*$ and $y_W^*>y_K^*$. A consumer at (x,y) buys product 1 at retailer *K* if and only if $x>x_1^*$ and $y<y_K^*$. Therefore $D_1^K=(1-x_1^*)y_K^*$. A consumer at (x,y) buys product 2 at retailer *W* if and only if $x<x_2^*$ and $y>y_W^*$. Therefore $D_2^W=x_1^*(1-y_W^*)$. A consumer at (x,y) in $(x_1^*,x_2^*)\times(y_K^*,y_W^*)$ such that

$$x=\frac{r_2^K-r_1^W}{2t_r}+\frac{t+t_r}{2t_r}-\frac{t}{t_r}y$$

is indifferent between product 1 at retailer *W* and product 2 at retailer *K*. Therefore,

$$D_1^W = x_1^*y_W^* + \int_{y_W^*}^{y_K^*}\left(x_2^*+\frac{r_2^K-r_1^W}{2t_r}+\frac{t+t_r}{2t_r}-\frac{t}{t_r}y\right)dy$$

and

$$D_2^K = x_2^*y_K^* + \int_{y_W^*}^{y_K^*}\left(x_1^*+\frac{r_2^K-r_1^W}{2t_r}+\frac{t+t_r}{2t_r}-\frac{t}{t_r}y\right)dy,$$

which yield the expressions stated in part (i) of the lemma.

(ii) Derived similarly as in above.

(iii) Define $\tilde{y}_K^*$ as the location of a consumer indifferent between buying product 1 and product 2 from retailer K and $\tilde{x}_1^*$ as the location of a consumer indifferent between buying product 1 from either retailer. Then

$$\tilde{y}_K^* = \frac{1}{2} + \frac{r_2^K - r_1^K}{2t} \qquad \text{and} \qquad \tilde{x}_1^* = \frac{1}{2} + \frac{r_1^K - \tilde{r}_1^W}{2t_r}.$$

A consumer at $(x, y) \in [0,1-\tilde{x}_1^*] \times [0, \tilde{y}_K^*]$ buys product 1 from retailer K. Therefore, $\tilde{D}_1^K = \tilde{y}_K^*(1-\tilde{x}_1^*)$, which yields the expression stated in the lemma. To derive the demand of retailer W, who sells only product 1, consider a consumer $(x, y) \notin [0,1-\tilde{x}_1^*] \times [0, \tilde{y}_K^*]$, such that $x < \tilde{x}_1^*$ or $y > \tilde{y}_K^*$, and break the demand into two parts. Part one consists of those consumers with $x < \tilde{x}_1^*$ and $y < \tilde{y}_K^*$, which has a measure equal to $\tilde{x}_1^* \tilde{y}_K^*$. For those consumers $(x, y) \notin [0,1-\tilde{x}_1^*] \times [0, \tilde{y}_K^*]$ such that $y > \tilde{y}_K^*$, they will buy (product 1) from retailer W if and only if

$$x \le \frac{r_2^K - \tilde{r}^W + t + t_r}{2t_r} - \frac{t}{t_r} y \equiv h(y).$$

Note that under the assumption A2' and $r_2^K - \tilde{r}^W > \frac{1}{8}$, $h(1) \ge 0$. The second part of the retailer W's demand is the area "under" $h(y)$ from $\tilde{y}_K^*$ to 1. Thus, total demand is

$$\tilde{D}_1^W = \tilde{x}_1^* \tilde{y}_K^* + \int_{\tilde{y}_K^*}^1 h(y) dy,$$

which, upon evaluation, yields the expression given in the statement of the lemma. Finally, since we assume that all consumers make a purchase, demand $\tilde{D}_2^K$ can be determined by computing the remaining area left over from the two demands computed above. Q.E.D.

Before proving Proposition S2, we derive equilibrium conditions for symmetric wholesale prices $\hat{p}^W, \hat{p}^K$. The derivation here is parallel to that of the basic model, which involves, first, determining the optimal stage 2 pricing behavior of the retailers given wholesale prices determined in stage 1 negotiations.

Using Lemma S2, the payoff to retailer j when carrying both products is

$$\hat{\Pi}_j = \sum_{i=1,2}(r_i^j - p_i^j - c^j)D_i^j \ ,$$

where D_i^j are expressed in Lemma A2. Setting $d\hat{\Pi}_j / dr_i^j = 0$ and invoking symmetry across products gives the optimal second stage pricing rules when retailer *j*:

$$r^j = t_r + \tfrac{2}{3}(p^j + c^j) + \tfrac{1}{3}(p^j + c^j) \ ,$$

which is analogous to (5). When negotiations between retailer *j* and manufacturer *i* end in disagreement, leaving *j* to sell only product $m \neq i$ in stage 2, it sets retail price $\tilde{r}^j$ in order to maximize

$$\hat{\Pi}_j^{-i} = (\tilde{r}^j - p^j - c^j)\tilde{D}_m^j \, .$$

Setting $d\Pi_j^{-i} / d\tilde{r}^j = 0$ and invoking symmetry, $p^j = p_i^j = p_2^j$, gives the optimal second stage pricing rule when retailer j sells only product *m*: $\tilde{r}^j = r^j - \frac{1}{8}$. Note that retailer j's optimal pricing rules with informed consumers, mimics those of the original model.[2]

The payoffs relevant for stage 1 negotiations, given optimal retailer behavior, in stage 2, are agreement payoffs $\hat{\Pi}_j \, , \hat{V}_i$ and disagreement payoffs $\hat{\Pi}_j^{-i} \, , \hat{V}_i^{-j}$ $i = 1,2$; $j = W, K$; $l \neq j$. For the model with informed consumers, the expressions for the agreement payoffs for both manufacturer and retailer remain as in equations (9) and (11). The disagreement payoff for retailer i also remains as before in (11). The important distinction between the two models occurs in the disagreement payoff of the manufacturer, which in the case of informed consumers is

$$\hat{V}_i^{-j} = \frac{p^j}{2}\left[\frac{1}{2} + \frac{3t}{16t_r} + \frac{(p^l - p^j) + (c^l - c^j)}{6t_r}\right].$$

The Nash bargaining solution is used to determine the outcome of the stage 1 negotiations. Specifically, $\hat{p}^j = \arg\max(\hat{\Pi}_j - \hat{\Pi}_j^{-i})(\hat{V}_i - \hat{V}_i^{-j})$, $j = W, K$. First order conditions for this maximization problem imply that prices $\hat{p}^W, \hat{p}^K$ in an equilibrium with informed consumers, must satisfy the following system:

[2] Assumption A2' is sufficient, but not necessary, for this to be the case. If Assumption A2' is relaxed, it is possible that these pricing rules change. In particular, by relaxing A2', the product demands of Lemma A2 (iii) are not guaranteed to hold, which alters the retailer's first order condition with respect to $\tilde{r}^j$.

$$\frac{t}{2}\left(t_r+\frac{\Delta_c}{3}+\frac{\hat{p}^K-\hat{p}^W}{3}-\frac{t}{16}\right)-\hat{p}^W\left(t_r+\frac{\Delta_c}{3}+\frac{\hat{p}^K-\hat{p}^W}{3}\right)+\frac{3t}{8}\hat{p}^K=0 \tag{S.12}$$

$$\frac{t}{2}\left(t_r-\frac{\Delta_c}{3}-\frac{\hat{p}^K-\hat{p}^W}{3}-\frac{t}{16}\right)-\hat{p}^K\left(t_r-\frac{\Delta_c}{3}-\frac{\hat{p}^K-\hat{p}^W}{3}\right)+\frac{3t}{8}\hat{p}^W=0\,. \tag{S13}$$

The second order necessary condition for this maximization is identical to that of the original model, which is given in (A.5).

Proof of Proposition S2

Define the LHS expressions of (S.12) and (S.13) as functions $H_W(p^W)$ and $H_K(p^K)$, which are decreasing under the second order condition for the maximization defined by the Nash bargaining solution. Substituting the (uninformed) equilibrium prices $\overline{p}^W, \overline{p}^K$ gives

$$H_W(\overline{p}^W)=\frac{t}{4}p^K>0=H_W(\hat{p}^W)$$

$$H_K(\overline{p}^K)=\frac{t}{4}p^W>0=H_K(\hat{p}^K)\,,$$

since $\overline{p}^W, \overline{p}^K$ solve (A.1) and (A.2) and $\hat{p}^W, \hat{p}^K$ solve (S.12) and (S.13). The decreasing property of H_j implies the result. Q.E.D.

The proposition states when the ratio t_r/t is sufficiently large, the manufacturer obtains a larger wholesale price as a result of informed consumers. And, as we illustrate numerically in the next section, this can improve manufacturers' profits.

Since our intent is to illustrate how consumer information might possibly improve the bargaining position of the manufacturer, we have not fully characterized the wholesale pricing outcome under other conditions. In particular, the question of whether consumers' product information can reduce wholesale prices when A2' does not hold remains unanswered.

S.4.2 Distribution of Surplus with Informed Consumers

In this section, we establish that informing consumers can improve manufacturer profits. In particular, we illustrate cases where $\hat{V} > V$. Table S2 presents a sample of such results from numerical simulations. Note that manufacturer profits increase in the presence information.

The previous section illustrated that consumer information about products can raise the marginal cost of retailers by $\hat{p}^j - \overline{p}^j$. It is not necessarily the case, however, that retailers suffer a loss in profits. In fact, because retailers retain a portion of the additional (marginal) extracted surplus generated from the coordinated increase in retail price, the advantaged retailer will benefit for all $\Delta_c \geq 0$.

What is particularly noteworthy about this last result is that even though consumers become better informed, they can be worse off. This counter-intuitive result stems from the collusive effect discussed above. Consequently, information does not necessarily always lead to more competitive outcomes.

Δ_c	p^K	p^W	r^K	r^W	Π^K	Π^W	*CS*	V_i
0.0	0.528	0.528	3.778	3.778	0.625	0.625	0.35	0.2639
0.0*	0.559	0.559	3.809	3.809	0.625	0.625	0.32	0.2794
0.2	0.529	0.527	3.711	3.644	0.559	0.694	0.45	0.2639
0.2*	0.561	0.557	3.743	3.675	0.559	0.695	0.42	0.2794
0.4	0.530	0.526	3.645	3.511	0.498	0.767	0.55	0.2639
0.4*	0.563	0.555	3.677	3.541	0.496	0.768	0.52	0.2795
0.6	0.531	0.525	3.579	3.377	0.439	0.843	0.65	0.2639
0.6*	0.566	0.554	3.612	3.408	0.438	0.846	0.62	0.2795
0.8	0.532	0.525	3.513	3.244	0.385	0.923	0.75	0.2639
0.8*	0.569	0.553	3.547	3.275	0.383	0.927	0.71	0.2796
1.0	0.534	0.524	3.447	3.111	0.334	1.007	0.85	0.2640
1.0*	0.572	0.552	3.482	3.142	0.331	1.011	0.81	0.2797
1.2	0.536	0.524	3.382	2.978	0.286	1.094	0.95	0.2640
1.2*	0.576	0.551	3.418	3.009	0.283	1.100	0.91	0.2798
1.4	0.538	0.524	3.316	2.845	0.242	1.185	1.04	0.2640
1.4*	0.580	0.551	3.354	2.877	0.239	1.192	1.01	0.2799
1.6	0.540	0.523	3.251	2.712	0.202	1.280	1.14	0.2641
1.6*	0.585	0.550	3.290	2.745	0.199	1.289	1.11	0.2801
1.8	0.543	0.523	3.186	2.580	0.166	1.379	1.24	0.2642
1.8*	0.591	0.550	3.228	2.614	0.162	1.390	1.20	0.2803

* Denotes Consumer Information Regime

Table S2 Distribution of Profits & Surplus over Product Information Regimes
($t = 1.00$, $t_r = 1.25$, $c^K = 2$, $\Delta_c = c^K - c^W$)

S.5 Numerical Details for Section 3

This section provides more detailed results from the numerical calculations used in Figures 3-6 in Section 3.

Δ_c	t_r	p^K	p^W	r^K	r^W	Π^K	Π^W	CS	V_i
0.0	1.00	0.536	0.536	3.536	3.536	0.500	0.500	0.71	0.2679
0.0	1.25	0.528	0.528	3.778	3.778	0.625	0.625	0.35	0.2639
0.2	1.00	0.537	0.534	3.470	3.402	0.435	0.570	0.81	0.2679
0.2	1.25	0.529	0.527	3.711	3.644	0.559	0.694	0.45	0.2639
0.4	1.00	0.539	0.533	3.404	3.269	0.374	0.645	0.91	0.2679
0.4	1.25	0.530	0.526	3.645	3.511	0.498	0.767	0.55	0.2639
0.6	1.00	0.541	0.533	3.338	3.135	0.318	0.723	1.01	0.2679
0.6	1.25	0.531	0.525	3.579	3.377	0.439	0.843	0.65	0.2639
0.8	1.00	0.543	0.532	3.273	3.002	0.266	0.807	1.11	0.2680
0.8	1.25	0.532	0.525	3.513	3.244	0.385	0.923	0.75	0.2639
1.0	1.00	0.546	0.531	3.208	2.869	0.219	0.896	1.21	0.2680
1.0	1.25	0.534	0.524	3.447	3.111	0.334	1.007	0.85	0.2640
1.2	1.00	0.549	0.531	3.143	2.737	0.176	0.988	1.31	0.2681
1.2	1.25	0.536	0.524	3.382	2.978	0.286	1.094	0.95	0.2640
1.4	1.00	0.553	0.531	3.079	2.605	0.138	1.086	1.41	0.2682
1.4	1.25	0.538	0.524	3.316	2.845	0.242	1.185	1.04	0.2640
1.6	1.00	0.557	0.531	3.015	2.473	0.105	1.189	1.51	0.2684
1.6	1.25	0.540	0.523	3.251	2.712	0.202	1.280	1.14	0.2641
1.8	1.00	0.563	0.531	2.952	2.342	0.076	1.297	1.60	0.2686
1.8	1.25	0.543	0.523	3.186	2.580	0.166	1.379	1.24	0.2642

Table S2 Distribution of Profits & Surplus

($t = 1$, $c^K = 2$, $\Delta_c = c^K - c^W$)

Δ_c	t	p^K	p^W	r^K	r^W	Π^K	Π^W	CS	V_i
0.0	1.00	0.536	0.536	3.536	3.536	0.500	0.500	0.7	0.2679
0.0	1.25	0.683	0.683	3.683	3.683	0.500	0.500	0.5	0.3414
0.2	1.00	0.537	0.534	3.47	3.402	0.435	0.570	0.8	0.2679
0.2	1.25	0.685	0.681	3.617	3.549	0.434	0.570	0.6	0.3415
0.4	1.00	0.539	0.533	3.404	3.269	0.374	0.645	0.9	0.2679
0.4	1.25	0.688	0.68	3.552	3.416	0.373	0.645	0.7	0.3415
0.6	1.00	0.541	0.533	3.338	3.135	0.318	0.723	1.0	0.2679
0.6	1.25	0.69	0.678	3.486	3.282	0.317	0.725	0.8	0.3416
0.8	1.00	0.543	0.532	3.273	3.002	0.266	0.807	1.1	0.2680
0.8	1.25	0.694	0.677	3.422	3.149	0.265	0.810	0.9	0.3416
1.0	1.00	0.546	0.531	3.208	2.869	0.219	0.896	1.2	0.2680
1.0	1.25	0.698	0.677	3.357	3.017	0.217	0.898	1.0	0.3418
1.2	1.00	0.549	0.531	3.143	2.737	0.176	0.988	1.3	0.2681
1.2	1.25	0.702	0.676	3.294	2.885	0.175	0.993	1.1	0.3419
1.4	1.00	0.553	0.531	3.079	2.605	0.138	1.086	1.4	0.2682
1.4	1.25	0.708	0.676	3.231	2.753	0.137	1.092	1.2	0.3421
1.6	1.00	0.557	0.531	3.015	2.473	0.105	1.189	1.5	0.2684
1.6	1.25	0.715	0.676	3.168	2.622	0.103	1.195	1.3	0.3424
1.8	1.00	0.563	0.531	2.952	2.342	0.076	1.297	1.6	0.2686
1.8	1.25	0.723	0.677	3.107	2.492	0.074	1.304	1.4	0.3428

Table S3 Effects from Changes in Brand Differentiation
($t_r = 1,\ c^K = 2,\ \Delta_c = c^K - c^W$)