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CONSUMER PSEUDO-SHOWROOMING AND OMNI-CHANNEL PLACEMENT STRATEGIES

Zheyin (Jane) Gu
University of Connecticut, 2100 Hillside Road, Unit 1041,
Storrs, CT 06269 U.S.A. {jane.gu@business.uconn.edu}

Giri Kumar Tayi
State University of New York at Albany, 1400 Washington Avenue,
Albany, NY 12222 U.S.A. {gtayi@albany.edu}

Appendix

Proof of Lemma 1

When $p_i \leq G$, the interior solution of the optimal price is $p_i^{LL*} = \frac{G}{2(1-\alpha)}$, which sustains only if $\frac{p_i^*}{G} = \frac{1}{2(1-\alpha)} \leq 1$, or $\alpha \leq \frac{1}{2}$. If $\alpha > \frac{1}{2}$, the corner solution $p_i^{LL*} = G$ constitutes the optimal price. The firm's maximized profit from selling product i can then be derived as

$$\pi_i^{LL*} = \begin{cases} \frac{G}{4(1-\alpha)} & if \quad \alpha \leq \frac{1}{2} \\ \alpha G & if \quad \alpha > \frac{1}{2} \end{cases} \tag{1}$$

The firm's total profit from selling the two products is

$$\Pi^{LL*} = \pi_1^{LL*} + \pi_2^{LL*} = \begin{cases} \frac{G}{2(1-\alpha)} & if \quad \alpha \leq \frac{1}{2} \\ 2\alpha G & if \quad \alpha > \frac{1}{2} \end{cases} \tag{2}$$

We derive type i consumers' total surplus at the optimal price p_i^{LL*} as follows.

$$\gamma_i^{LL*} = \alpha(G - p_i^{LL*}) + (1-\alpha)\int_{\frac{p_i^{LL*}}{G}}^{1} (\beta G - p_i^{LL*}) dF\beta = \begin{cases} \frac{(1-4\alpha^2)G}{8(1-\alpha)} & if \quad \alpha \leq \frac{1}{2} \\ 0 & if \quad \alpha > \frac{1}{2} \end{cases} \tag{3}$$

And the total consumer surplus is

$$\Gamma^{LL*} = \gamma_1^{LL*} + \gamma_2^{LL*} = \begin{cases} \frac{(1-4\alpha^2)G}{4(1-\alpha)} & if \quad \alpha \leq \frac{1}{2} \\ 0 & if \quad \alpha > \frac{1}{2} \end{cases} \tag{4}$$

Proof of Lemma 2

In case LE, the firm's optimal selling price for product 1, which is offered through the dual channel, is the same as that in case LL. To solve the firm's optimal selling price for product 2, which is offered through the online channel exclusively, we consider two conditions, $r \leq \alpha$ and $r > \alpha$.

(1) $r \leq \alpha$. In this case, the firm's profit function for selling product 2 is

$$\pi_2^{LE} = \begin{cases} p_2 & if \quad p_2 \leq rG \\ (1 - \frac{p_2}{G} + r)p_2 + (\frac{p_2}{G} - r)(\alpha p_2 - (1-\alpha)hG) & if \quad rG < p_2 \leq (1 + r - \frac{r}{\alpha})G \\ \frac{G-p_2}{G(1-\alpha)} p_2 & if \quad p_2 > (1 + r - \frac{r}{\alpha})G \end{cases} \tag{5}$$

We consider the following possible firm pricing strategies.

(1.1) If $p_2 \leq rG$, all type 2 consumers buy the product from the online store and all keep the product regardless of the realized fit; the optimal price is $p_2^{LE*} = rG$; the maximized firm profit is $\pi_2^{LE*} = rG$.

(1.2a) If $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$, the interior solution is $p_2^{LE*} = \frac{1+(r-h)(1-\alpha)}{2(1-\alpha)}G$, which sustains if $0 \leq \alpha \leq \frac{1+h}{2+h}$ (note that $\frac{1+h}{2+h} > \frac{1}{2}$) & $r \leq \underline{r} = \frac{\alpha-2\alpha^2+h\alpha(1-\alpha)}{2-3\alpha+\alpha^2}$; the maximized firm profit is $\pi_2^{LE*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)}G$.

(1.2b) If $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$, the corner solution is $p_2^{LE*} = (1 + r - \frac{r}{\alpha})G$; the maximized firm profit is $\pi_2^{LE*} = \frac{(-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G$.

(1.3) If $p_2 > (1+r-\frac{r}{\alpha})G$, the interior solution is $p_2^{LE*} = \frac{1}{2}G$, which sustains if $\{0 \leq \alpha \leq \frac{1}{2} \& \alpha_3 = \frac{\alpha}{2(1-\alpha)} < r \leq \alpha\}$; the maximized firm profit is $\pi_2^{LE*} = \frac{1}{4(1-\alpha)}G$.

Clearly, strategy (1.1) and (1.2b) always sustain; and strategy (1.2b) dominates strategy (1.1) is always satisfied, in parameter regions $\{0 < \alpha \leq \frac{1+h}{2+h} \& \underline{r} < r \leq \alpha\}$ and $\{\frac{1+h}{2+h} < \alpha < 1 \& 0 \leq r \leq \alpha\}$. Moreover, strategy (1.2b) dominates strategy (1.3) if $\{\frac{2h}{1+2h} \leq \alpha \leq \frac{1}{2} \& \frac{\alpha}{2(1-\alpha)} < r < \overline{r} = \frac{\alpha(1+h-\alpha)}{2(1-\alpha)} + \frac{\alpha}{2(1-\alpha)}\sqrt{\frac{h^2(1-\alpha)-2h(1-\alpha)^2+\alpha(1-\alpha-\alpha^2)}{1-\alpha}}\}$.

(2) $r > \alpha$. In this case, the firm's profit function for product 2 is $\pi_2^{LE*} = \begin{cases} p_2 & if \quad p_2 \leq \alpha G \\ \frac{G-p_2}{G(1-\alpha)}p_2 & if \quad p_2 > \alpha G \end{cases}$.

We consider the following possible firm pricing strategies.

(2.1) If $p_2 \leq \alpha G$, all type 2 consumers buy the product from the online store and all keep the product regardless of the realized fit; the optimal price is $p_2^{LE*} = \alpha G$; the maximized firm profit is $\pi_2^{LE*} = \alpha G$.

(2.2) If $p_2 > \alpha G$, the interior solution is $p_2^{LE*} = \frac{1}{2}G$, which sustains if $\alpha < \frac{1}{2}$; the maximized firm profit is $\pi_2^{LE*} = \frac{1}{4(1-\alpha)}G$.

It can be proved that when strategy (2.2) is feasible, it always dominates strategy (2.1).

Summarizing the above discussion we obtain Lemma 2.

Proof of Lemma 3

If $r \leq \alpha$, type 2 consumers' total surplus from buying product 2 can be derived as

$$\gamma_2^{LE} = \begin{cases} \begin{array}{c} \alpha(G-p_2) + (1-\alpha)\int_0^1 \beta G - p_2)dF\beta \\ = \frac{(1+\alpha)}{2}G - p_2 \end{array} & if \quad p_2 \leq rG \\ \begin{array}{c} \alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2}{G}-r}^1((\beta G - p_2)dF\beta + \\ (1-\alpha)\int_0^{\frac{p_2}{G}-r}(-rG)dF\beta \\ = \alpha(G-p_2) + (1-\alpha)(\frac{G^2-2Gp_2+p_2^2-r^2G^2}{2G}) + \\ (1-\alpha)\frac{p_2-rG}{G}(-rG) \end{array} & if \quad rG < p_2 \leq (1+r-\frac{r}{\alpha})G \\ \begin{array}{c} \alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2-G\alpha}{G-G\alpha}}^1(\beta G - p_2)dF\beta \\ = (G-p_2)\alpha + \frac{(G-p_2)^2(1-2\alpha)}{2G(1-\alpha)} \end{array} & if \quad p_2 > (1+r-\frac{r}{\alpha})G. \end{cases} \qquad (6)$$

If $r > \alpha$, type 2 consumers' total surplus from buying product 2 can be derived as

$$\gamma_2^{LE} = \begin{cases} \begin{array}{c} \alpha(G-p_2) + (1-\alpha)\int_0^1((1-\beta)G - p_2)dF\beta \\ = \frac{(1+\alpha)}{2}G - p_2 \end{array} & if \quad p_2 \leq \alpha G \\ \begin{array}{c} \alpha(G-p_2) + (1-\alpha)\int_0^{\frac{G-p_2}{G(1-\alpha)}}((1-\beta)G - p_2)dF\beta \\ = (G-p_2)\alpha + \frac{(G-p_2)^2(1-2\alpha)}{2G(1-\alpha)} \end{array} & if \quad p_2 > \alpha G \end{cases} \qquad (7)$$

Given the optimal price p_2^{LE*}, we derive type 2 consumers' total surplus in the following regions.

Region A: $p_2^{LE*} = \frac{(1+(r-h)(1-\alpha)}{2(1-\alpha)}G$, and $\gamma_2^{LE*} = \frac{G(1+h^2(1-\alpha)^2+2h(1+r(1-\alpha))(1-\alpha)-6r(1-\alpha)+r^2(1-\alpha^2)-4\alpha^2)}{8(1-\alpha)}$.

Region B: $p_2^{LE*} = (1+r-\frac{r}{\alpha})G$, and $\gamma_2^{LE*} = \frac{Gr^2(1-\alpha)}{2\alpha^2}$.

Region C: $p_2^{LE*} = \frac{1}{2}G$ and $\gamma_2^{LE*} = \frac{G(1+2\alpha-4\alpha^2)}{8(1-\alpha)}$.

Region D: $p_2^{LE*} = \alpha G$ and $\gamma_2^{LE*} = \frac{1-\alpha}{2}G$.

Proof of Proposition 1

Note that to compare Π^{LL*} and Π^{LE*}, we only need to compare π_2^{LL*} and π_2^{LE*}. We summarize the firm's maximized profit from selling product 2 in cases LL and LE/EL in the Table A1.

Table A1. Comparing Firm Maximized Profit in Case LL (π_2^{LL*}) and Case LE (π_2^{LE*})

Region	*Parameter Range*	π_2^{LL*}	π_2^{LE*}
A	(i) $0 \le \alpha \le \frac{1}{2}$ & $r \le \underline{r}$	$\frac{G}{4(1-\alpha)}$	$\frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)}G$
	(ii) $\frac{1}{2} < \alpha \le \frac{1+h}{2+h}$& $r \le \underline{r}$	αG	
B	(ii) $\{0 \le \alpha \le \frac{1}{2}\&\underline{r} < r \le \max\{\frac{\alpha}{2(1-\alpha)}, \overline{r}\}$	$\frac{G}{4(1-\alpha)}$	$\frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G$
	(ii) $\{\frac{1}{2} < \alpha \le \frac{1+h}{2+h}\&\underline{r} < r \le \alpha\}$ $\cup\{\frac{1+h}{2+h} < \alpha \le 1\&0 \le r \le \alpha\}$	αG	
C	$\{0 \le \alpha \le \frac{1}{2}\&r > \max\{\frac{\alpha}{2(1-\alpha)}, \overline{r}\}$	$\frac{G}{4(1-\alpha)}$	$\frac{G}{4(1-\alpha)}$
D	$\frac{1}{2} \le \alpha \le 1\&r > \alpha$	αG	αG

$$\underline{r} = \frac{\alpha - 2\alpha^2 + h\alpha(1-\alpha)}{2 - 3\alpha + \alpha^2}; \tag{8}$$

$$\overline{r} = \frac{\alpha(1+h-\alpha)}{2(1-\alpha)} + \frac{\alpha}{2(1-\alpha)}\sqrt{\frac{h^2(1-\alpha) - 2h(1-\alpha)^2 + \alpha(1-\alpha-\alpha^2)}{1-\alpha}}. \tag{9}$$

We compare π_2^{LL*} and π_2^{LE*} in the following regions.

Region A:

(i) $\pi_2^{LE*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)}G > \pi_2^{LL*} = \frac{G}{4(1-\alpha)}$ is satisfied if $\frac{\sqrt{1+4h(1-\alpha)}-1-h(1-\alpha)}{1-\alpha} < r \le \underline{r}$.

(ii) $\pi_2^{LE*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)}G > \pi_2^{LL*} = \alpha G$ is satisfied only if $2\sqrt{\frac{h+\alpha}{1-\alpha}} - \frac{1+h(1-\alpha)}{1-\alpha} < r \le \underline{r}$, which is never satisfied since $2\sqrt{\frac{h+\alpha}{1-\alpha}} - \frac{1+h(1-\alpha)}{1-\alpha} > \underline{r}$; therefore, $\pi_2^{LL*} > \pi_2^{LE*}$ is always satisfied in the case.

Region B:

(i) $\pi_2^{LE*} = \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G > \pi_2^{LL*} = \frac{G}{4(1-\alpha)}$ is satisfied if $\frac{2h}{1+2h} \le \alpha \le \frac{1}{2}\&\ r < \overline{r}$.

(ii) $\pi_2^{LE*} = \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G > \pi_2^{LL*} = \alpha G$ is satisfied if $\{\frac{1}{2} \le \alpha \le 1 - h\&\frac{h\alpha}{1-\alpha} < r \le \alpha\}$.

Region C: $\pi_2^{LE*} = \frac{1}{4(1-\alpha)}G = \pi_2^{LL*} = \frac{G}{4(1-\alpha)}$.

Region D: $\pi_2^{LE*} = 2\alpha G = \pi_2^{LL*} = 2\alpha G$.

Summarizing the above discussion, we obtain Proposition 1.

Proof of Proposition 2

Note that to compare Γ^{LL*} and Γ^{LE*}, we only need to compare γ_2^{LL*} and γ_2^{LE*}. We summarize type 2's consumers' total surplus in case LL and case LE/EL in Table A2.

Table A2. Comparing Type 2 Consumers' Surplus in Case LL (γ_2^{LL*}) and Case LE (γ_2^{LE*})

Region	*Parameter Range*	γ_2^{LL*}	γ_2^{LE*}
A	(i) $0 \le \alpha \le \frac{1}{2}$ & $r \le \underline{r}$	$\frac{(1-4\alpha^2)G}{8(1-\alpha)}$	$\frac{(1+h^2(1-\alpha)^2+2h(1+r(1-\alpha))(1-\alpha))G}{8(1-\alpha)}+\frac{(-6r(1-\alpha)+r^2(1-\alpha^2)-4\alpha^2)G}{8(1-\alpha)}$
	(ii) $\frac{1}{2} < \alpha \le \frac{1+h}{2+h}$& $r \le \underline{r}$	0	
B	(ii) $\{0 \le \alpha \le \frac{1}{2}$& $\underline{r} < r \le \max\{\frac{\alpha}{2(1-\alpha)}, \overline{r}\}$	$\frac{(1-4\alpha^2)G}{8(1-\alpha)}$	$\frac{r^2(1-\alpha)G}{2\alpha^2}$
	(ii) $\{\frac{1}{2} < \alpha \le \frac{1+h}{2+h}$&$\underline{r} < r \le \alpha\}$ $\cup\{\frac{1+h}{2+h} < \alpha \le 1$&$0 \le r \le \alpha\}$	0	
C	$\{0 \le \alpha \le \frac{1}{2}$&$r > \max\{\frac{\alpha}{2(1-\alpha)}, \overline{r}\}$	$\frac{(1-4\alpha^2)G}{8(1-\alpha)}$	$\frac{(1+2\alpha-4\alpha^2)G}{8(1-\alpha)}$
D	$\frac{1}{2} \le \alpha \le 1$&$r > \alpha$	0	$\frac{(1-\alpha)G}{2}$

We compare γ_2^{LL*} and γ_2^{LE*} in the following regions.

Region A:

(i) $\gamma_2^{LE*} = \frac{G(1+h^2(1-\alpha)^2+2h(1+r(1-\alpha))(1-\alpha)-6r(1-\alpha)+r^2(1-\alpha^2)-4\alpha^2)}{8(1-\alpha)} > \gamma_2^{LL*} = \frac{(1-4\alpha^2)G}{8(1-\alpha)}$is satisfied if $r < \frac{3-h(1-\alpha)-\sqrt{9-8h+4h\alpha-2h^2\alpha+2h^2\alpha^2}}{1+\alpha}$.

(ii) $\gamma_2^{LE*} = \frac{G(1+h^2(1-\alpha)^2+2h(1+r(1-\alpha))(1-\alpha)-6r(1-\alpha)+r^2(1-\alpha^2)-4\alpha^2)}{8(1-\alpha)} > \gamma_2^{LL*} = 0$ is always satisfied.

Region B:

(i) $\gamma_2^{LE*} = \frac{Gr^2(1-\alpha)}{2\alpha^2} > \gamma_2^{LL*} = \frac{(1-4\alpha^2)G}{8(1-\alpha)}$ is satisfied if and only if $\frac{1}{2}\sqrt{\frac{\alpha^2-4\alpha^4}{(1-\alpha)^2}} < r \le \overline{r}$.

(ii) $\gamma_2^{LE*} = \frac{Gr^2(1-\alpha)}{2\alpha^2} > \gamma_2^{LL*} = 0$ is always satisfied.

Region C: $\gamma_2^{LE*} = \frac{1+2\alpha-4\alpha^2}{8(1-\alpha)}G > \gamma_2^{LL*} = \frac{(1-4\alpha^2)G}{8(1-\alpha)}$ is always satisfied.

Region D: $\gamma_2^{LE*} = \frac{1-\alpha}{2}G > \gamma_2^{LL*} = 0$ is always satisfied.

Summarizing the above discussion, we obtain Proposition 2.

Proof of Corollary 1

In region A, $\pi_2^{LE*} > \pi_2^{LL*}$ is satisfied if $r > \frac{\sqrt{1+4h(1-\alpha)}-1-h(1-\alpha)}{1-\alpha}$ and $\gamma_2^{LE*} > \gamma_2^{EL*}$ is satisfied when $r < \frac{3-h(1-\alpha)-\sqrt{9-8h+4h\alpha-2h^2\alpha+2h^2\alpha^2}}{1+\alpha}$. It can be proved that $\frac{\sqrt{1+4h(1-\alpha)}-1-h(1-\alpha)}{1-\alpha} > \frac{3-h(1-\alpha)-\sqrt{9-8h+4h\alpha-2h^2\alpha+2h^2\alpha^2}}{1+\alpha}$ is always satisfied and therefore $\pi_2^{LE*} > \pi_2^{LL*}$ and $\gamma_2^{LE*} > \gamma_2^{EL*}$ are never simultaneously satisfied. Proof of results in other regions is trivial.

Proof of Proposition 3

We first consider the case when the two products have vertical qualities of G^h and $G^l (0 < G^l < G^h)$ respectively. It is easy to see that given product placement strategy $S(S = LL, LE, EL)$, the firm's maximized profit from selling product 1, π_1^{S*}, is just its profit from selling product 1 as derived in the main model, with G replaced by G^h, and the firm's maximized profit from selling product 2, π_2^{S*}, is just its profit from selling product 2 as derived in the main model, with G replaced by G^l. The firm's maximized total profit is the sum of its maximized profit from both products, $\Pi^{S*} = \pi_1^{S*} + \pi_2^{S*}$. Note that in this situation firm strategies LE and EL are not symmetric any more, $\Pi^{LE*} \neq \Pi^{EL*}$. We summarize the firm's total profit under various strategies in Table A3.

Table A3. Firm's Maximized Payoffs with Asymmetric Product Quality

Region	*Parameter Range*	Π^{LL*}
A	(i) $0 \le \alpha \le \frac{1}{2}$ & $r \le \underline{r}$	$\Pi^{LL*} = \frac{G^h+G^l}{4(1-\alpha)}$ $\Pi^{LE*} = \frac{G^h}{4(1-\alpha)} + \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)} G^l$ $\Pi^{EL*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)} G^h + \frac{G^l}{4(1-\alpha)}$
	(ii) $\frac{1}{2} < \alpha \le \frac{1+h}{2+h}$& $r \le \underline{r}$	$\Pi^{LL*} = \frac{G^h+G^l}{4(1-\alpha)}$ $\Pi^{LE*} = \alpha G^h + \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)} G^l$ $\Pi^{EL*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-r(1-\alpha))(1-\alpha)}{4(1-\alpha)} G^h + \alpha G^l$
B	(ii) $0 \le \alpha \le \frac{1}{2}\&$ $\underline{r} < r \le \max\{\frac{\alpha}{2(1-\alpha)}, \overline{r}\}$	$\Pi^{LL*} = \frac{G^h+G^l}{4(1-\alpha)}$ $\Pi^{LE*} = \frac{G^h}{4(1-\alpha)} + \frac{(r(-1+\alpha)+\alpha)(r-r\alpha+\alpha^2)}{\alpha^2} G^l$ $\Pi^{EL*} = \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2} G^h + \frac{G^l}{4(1-\alpha)}$
	(ii) $\{\frac{1}{2} < \alpha \le \frac{1+h}{2+h} \& \underline{r} < r \le \alpha\}$ $\cup \{\frac{1+h}{2+h} < \alpha \le 1 \& 0 \le r \le \alpha\}$	$\Pi^{LL*} = \alpha(G^h + G^l)$ $\Pi^{LE*} = \alpha G^h + \frac{(r(-1+\alpha)+\alpha)(r-r\alpha+\alpha^2)}{\alpha^2} G^l$ $\Pi^{EL*} = \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2} G^h + \alpha G^l$
C	$\{0 \le \alpha \le \frac{1}{2} \& r > \max\{\frac{\alpha}{2(1-\alpha)}, \overline{r}\}$	$\Pi^{LL*} = \Pi^{LE*} = \Pi^{EL*} = \frac{G^h+G^l}{4(1-\alpha)}$
D	$\frac{1}{2} \le \alpha \le 1 \& r > \alpha$	$\Pi^{LL*} = \Pi^{LE*} = \Pi^{EL*} = \alpha(G^h + G^l)$

It is easy to see that $\Pi^{LE*} > \Pi^{LL*}$ and $\Pi^{EL*} > \Pi^{LL*}$ are both satisfied in regions defined in Proposition 1 and illustrated in Figure 1 where strategy LE is more profitable than strategy LL. Moreover, in these regions, $\Pi^{LE*} < \Pi^{EL*}$ is always satisfied, since the firm's profit from selling a product always increases with the product's vertical quality.

We then consider the case when the two products have consumer demand of sizes 1 and $s(0 < s < 1)$, respectively. Given the product placement strategy $S(S = LL, LE, EL)$, the firm's maximized profit from selling product 1, π_1^{S*}, is just its profit from selling product 1 as derived in the main model, and the firm's maximized profit from selling product 2, π_2^{S*}, is just its profit from selling product 2 as derived in the main model multiplied by parameter s. The firm's maximized total profit is $\Pi^{S*} = \pi_1^{S*} + \pi_2^{S*}$. Again, in this situation firm strategies LE and EL are not symmetric, $\Pi^{LE*} \neq \Pi^{EL*}$. It is easy to see that $\Pi^{LE*} > \Pi^{LL*}$ and $\Pi^{EL*} > \Pi^{LL*}$ are both satisfied in regions defined in Proposition 1 where strategy LE is more profitable than strategy LL. Moreover, in these regions, $\Pi^{LE*} < \Pi^{EL*}$ is always satisfied, since the firm's profit from selling a product always increases with the product's demand size.

Proof of Robustness of Main Model Results Under Seller Competition

We first solve the worse case that the multi-channel seller A encounter, that is when type 2 consumers always prefer seller B's products to seller A's products, and thus always buy product B2 as long as her utility from purchasing product B2 is non-negative. We solve the model backwardly.

In case LL, seller A sells both products through the dual channel. In stage 3, type 1 consumers' behavior are the same as in the main model and therefore the seller's optimal pricing strategy is also the same as in the main model. We focus on analyzing type 2 consumers' behavior. Under our assumption, type 2 consumers who find a good fit with product B2 and those who find a bad fit with product B2 but a sufficiently high misfit tolerance $\beta_B \geq \frac{p_{B2}}{G}$ always buy product B2. Only a proportion $(1 - \alpha_B)\frac{p_{B2}}{G}$ of consumers who find a bad fit with product B2 and have low misfit tolerance level $\beta_B < \frac{p_{B2}}{G}$ will consider buying seller A's product A2. Among these consumers, only those who find a good fit with product A2 and those who find a bad fit with product A2 but a sufficiently high misfit tolerance level $\beta \geq \frac{p_{A2}}{G}$ will buy product A2. We write down the demand for product B2 as

$$D_{B2}^{LL} = (\alpha_B + (1 - \alpha_B)(1 - \frac{p_{B2}}{G})) \tag{10}$$

and the demand for product A2 as

$$D_{A2}^{LL} = (1-\alpha_B)\frac{p_{B2}}{G}(\alpha + (1-\alpha)(1-\frac{p_{A2}}{G})) \tag{11}$$

In stage 2, seller B's profit function $\pi_{B2}^{LL} = (\alpha_B + (1-\alpha_B)(1-\frac{p_{B2}}{G}))p_{B2}$ is maximized at the optimal price of

$$p_{B2}^{LL*} = \begin{cases} \frac{G}{2(1-\alpha_B)} & if \quad \alpha_B \le \frac{1}{2} \\ G & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{12}$$

Seller A's profit from selling product 2 thus reduces to

$$\pi_{A2}^{LL} = \begin{cases} \frac{1}{2}\pi_{A2}^{LL} & if \quad \alpha_B \le \frac{1}{2} \\ (1-\alpha_B)\pi_{A2}^{LL} & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{13}$$

where π_2^{LL*} is defined in equation (4) of the main model. Seller A's optimal price can be derived as

$$p_{A2}^{LL*} = \begin{cases} \frac{G}{2(1-\alpha)} & if \quad \alpha \le \frac{1}{2} \\ G & if \quad \alpha > \frac{1}{2} \end{cases} \tag{14}$$

It can be seen that this optimal price strategy is the same as in the main model (equation 7), that is, $p_{A2}^{LL*} = p_2^{LL*}$. Seller A's maximized profit from selling product A2 can thus be derived as

$$\pi_{A2}^{LL*} = \begin{cases} \frac{1}{2}\pi_{A2}^{LL*} = \frac{1}{2}\pi_2^{LL*} & if \quad \alpha_B \le \frac{1}{2} \\ (1-\alpha_B)\pi_{A2}^{LL*} = (1-\alpha_B)\pi_2^{LL*} & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{15}$$

where π_2^{LL*} is defined in equation (8) in the main model. The total surplus of type 2 consumers who don't buy product B2 is at the optimal price p_{A2}^{LL*} can be derived as

$$\gamma_{A2}^{LL*} = \begin{cases} \frac{1}{2}\gamma_{A2}^{LL*} = \frac{1}{2}\gamma_2^{LL*} & if \quad \alpha_B \le \frac{1}{2} \\ (1-\alpha_B)\gamma_{A2}^{LL*} = (1-\alpha_B)\gamma_2^{LL*} & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{16}$$

where γ_2^{LL*} is defined in equation (9) of the main model.

In case LE/EL, seller A sells one product through the online channel exclusively. The two cases are symmetric and we focus on analyzing case LE. In stage 3, among type 2 consumers, those who find a good fit with product B2 and those who have sufficiently high misfit tolerance level for product B2 still buy product B2. The remaining consumers consider buying product A2. It is easy to see that demand for product B2 and A2 are

$$\begin{aligned} D_{B2}^{LE} &= D_{B2}^{LL} \\ D_{A2}^{LE} &= (1-\alpha_B)\frac{p_{B2}}{G}D_2^{LE} \end{aligned}$$

where D_2^{LE} is defined in the main model (equations 11 and 13). In stage 2, it can be proved that seller B's optimal price for product 2 is the same as in case LL, $p_{B2}^{LE*} = p_{B2}^{LL*}$. Seller A's profit function for product A2 thus reduces to

$$\pi_{A2}^{LE} = \begin{cases} \frac{1}{2}\pi_{A2}^{LE} = \frac{1}{2}\pi_2^{LE} & if \quad \alpha_B \leq \frac{1}{2} \\ (1-\alpha_B)\pi_{A2}^{LE} = (1-\alpha_B)\pi_2^{LE} & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{17}$$

where π_2^{LE} are given in the main model (equations 12 and 14). It can be proved that in equilibrium, $p_{A2}^{LE*} = p_2^{LL*}$, where p_2^{LL*} is defined in the main model (Lemma 1). Seller A's maximized profit from selling product A2 is thus

$$\pi_{A2}^{LE*} = \begin{cases} \frac{1}{2}\pi_2^{LE*} & if \quad \alpha_B \leq \frac{1}{2} \\ (1-\alpha_B)\pi_2^{LE*} & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{18}$$

For those consumers who don't buy product B2, their total surplus can be derived as

$$\gamma_{A2}^{LE*} = \begin{cases} \frac{1}{2}\gamma_2^{LE*} & if \quad \alpha_B \leq \frac{1}{2} \\ (1-\alpha_B)\gamma_2^{LE*} & if \quad \alpha_B > \frac{1}{2} \end{cases} \tag{19}$$

π_2^{LE*} and γ_2^{LE*} are defined in Lemma 2 of the main model.

In Stage 1, the multi-channel seller A decides the optimal product placement strategy. Since seller A's optimal strategy and maximized profit from selling product A1 are the same in cases LL and LE, we only need to compare its payoffs from selling product A2. Comparing π_{A2}^{LE*} with π_{A2}^{LL*}, and comparing γ_{A2}^{LE*} with γ_{A2}^{LL*}, we obtain that our main model results regarding the benefits of inducing consumer pseudo-showrooming (Propositions 1 and 2, corollary 1) continues to hold.

We then consider the case when type 2 consumers choose between products A2 and B2 the one that provides the higher non-negative utility. In case LL, type 2 consumers find their misfit tolerance with both sellers' products, β and β_B, and also their true fit with both products A2 and B2. A proportion $\alpha\alpha_B$ of type 2 consumers find a good fit with both products, and have utilities of $U_{A2} = G - p_{A2}$ and $U_{B2} = G - p_{B2}$; a proportion $\alpha(1-\alpha_B)$ of type 2 consumers find a good fit with product A2 only, and have utilities of $U_{A2} = G - p_{A2}$ and $U_{B2} = \beta_B G - p_{B2}$; a proportion $\alpha_B(1-\alpha)$ of consumers find a good fit with product B2 only, and have utilities of $U_{A2} = \beta G - p_{A2}$ and $U_{B2} = G - p_{B2}$; lastly, a proportion $(1-\alpha)(1-\alpha_B)$ of consumers find a bad fit with both products, and have utilities of $U_{A2} = \beta G - p_{A2}$ and $U_{B2} = \beta_B G - p_{B2}$. A consumer buys product A2 if $U_{A2} > U_{B2}$, buys product B2 if $U_{A2} < U_{B2}$, and randomly chooses between the two products if $U_{A2} = U_{B2}$. All consumers keep their purchased product.

In case LE, type 2 consumers find their misfit tolerance with both sellers' products and their true fit with both products B2 only. A proportion α_B of consumers find a good fit with product B2 and have utility of $U_{B2} = G - p_{B2}$ and the remaining proportion $(1-\alpha_B)$ of consumers find a bad fit with product B2 and have utilities of $U_{B2} = \beta_B G - p_{B2}$. These consumers have to construct expected utility from ordering product A2 online, $E_f U_{A2}^E = E_f U_2^E$, with $E_f U_2^E$ defined in equation (10) of the main model. A consumer buys product A2 if $E_f U_{A2}^E > U_{B2}$, buys product B2 if $E_f U_{A2}^E < U_{B2}$, and randomly chooses between the two products if $E_f U_{A2}^E = U_{B2}$. Buyers of product A2 will return a misfit product ex-post if their misfit tolerance level is low, $\beta < \frac{p_{A2}}{G} - r$. Buyers of product B2 always keep the product. We solve the model through numerical simulation. Consistent with the main model results, we find that consumer pseudo-showrooming behaviors allow seller A to obtain a greater profit by offering product A2 through the online channel exclusively. For example, when G=1, α=α_B=0.3, r=0.1, and h=0.1, seller A's maximized profit from selling product A2 in case LL and case LE are 0.09 and 0.163, respectively. Since the size of consumers who buy product A2 over B2 in case LL and case LE are likely to be different, a fair comparison of consumer surplus is not eligible.

Proof of Results Regarding Inducing Consumer Pseudo-Showrooming versus Pure Online Selling

Firm Optimal Pricing Strategy in Case EE

In case EE when the firm sells both products through the online channel exclusively, the firm maximizes its total profit by maximizing its profit from selling each of the two products separately. And the two products are symmetric.

In stage 3, a type $i (i = 1, 2)$ consumer's *ex ante* utility from buying product i is

$$EU_i^E = \begin{cases} \alpha(G - p_i) + (1-\alpha)\int_{\frac{p_i}{G}-r}^{1}(\beta G - p_i)dF\beta + (1-\alpha)\int_0^{\frac{p_i}{G}-r}(-rG)dF\beta \\ \quad = \alpha(G-p_i) + \frac{(1-\alpha)}{2G}(p_i^2 - 2Gp_i(1+r) + G^2(1+r^2)) & if \quad \frac{p_i}{G} - r > 0 \\ \alpha(G-p_i) + (1-\alpha)\int_0^1(\beta G - p_i)dF\beta \\ \quad = \alpha(G-p_i) + (1-\alpha)(\frac{G}{2} - p_i) & if \quad \frac{p_i}{G} - r \le 0 \end{cases} \quad (20)$$

The consumer will order product i if $EU_i^E \ge 0$, which is satisfied if $rG < p_i \le (\frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})G$ (note that this condition can be satisfied only if $r \le \frac{1+\alpha}{2}$), or if $p_i \le \min\{rG, \frac{G(1+\alpha)}{2}\}$.

In stage 2, the firm's optimal strategy can be solved in the following conditions.

(i) If $r > \frac{1+\alpha}{2}$, the firm has only one feasible pricing strategy, $p_i \leq \frac{G(1+\alpha)}{2}$. Given the firm's profit function $\pi_i^{EE} = p_i$, the optimal price can be solved as $p_i^{EE*} = \frac{1+\alpha}{2}G$, which renders a maximized firm profit of $\pi_i^{EE*} = \frac{1+\alpha}{2}G$.

(ii) If $r \leq \frac{1+\alpha}{2}$, the firm has two feasible pricing strategies: $rG < p_i \leq (\frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})G$ and $p_i \leq rG$. The firm's profit function is

$$\pi_i^{EE} = \begin{cases} (1 - \frac{p_i}{G} + r)p_i + (\frac{p_i}{G} - r)(\alpha p_i - (1-\alpha)hG) \quad if & r < \frac{1+\alpha}{2} \\ & \& Gr < p_i \leq (\frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})G \\ p_i \quad if & p_i \leq rG \end{cases} \tag{21}$$

(ii.a) If $p_i \leq rG$: the firm's optimal price is $p_i^{EE*} = rG$, which renders a maximized firm profit of $\pi_i^{EE*} = rG$.

(ii.b) If $rG < p_i \leq (\frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})G$: the interior solution can be solved as $p_i^{EE*} = \frac{1+(r-h)(1-\alpha)}{2(1-\alpha)}G$, which sustains only if $\{0 < \alpha \leq \frac{1+h}{2+h} \& \; r \leq \frac{3-h(1-\alpha)-2\sqrt{2+\alpha^2-2h(1-\alpha)}}{1-\alpha}\}$ (note that $\frac{3-h(1-\alpha)-2\sqrt{2+\alpha^2-2h(1-\alpha)}}{1-\alpha} < \frac{1+\alpha}{2}$ is always satisfied). This strategy renders a maximized firm profit of $\pi_i^{EE*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-\alpha)(1-r(1-\alpha))}{4(1-\alpha)}G$.

Otherwise, if $\{\alpha > \frac{1+h}{2+h}$ or $r > \frac{3-h(1-\alpha)-2\sqrt{2+\alpha^2-2h(1-\alpha)}}{1-\alpha}\}$, the corner solution constitutes the optimal price, $p_i^{EE*} = \widehat{p}^{EE*} = (\frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})G$. This strategy renders a maximized firm profit of $\pi_i^{EE*} = \pi_i^{EE}(p_i = \widehat{p}^{EE*} = (\frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})G)$.

It can be proved that the firm profit in (ii.b) under the interior solution and the corner solution are both greater than the firm profit in (ii.a).

Summarizing conditions (i) and (ii), we obtain the firm's maximized profit from selling product i:

$$\pi_i^{EE*} = \begin{cases} \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-\alpha)(1-r(1-\alpha))}{4(1-\alpha)}G & if \quad r \leq \underline{r}^{EE} = \frac{3-h(1-\alpha)-2\sqrt{2+\alpha^2-2h(1-\alpha)}}{1-\alpha} \\ (1 - \frac{\widehat{p}^{EE*}}{G} + r)\widehat{p}^{EE*} + (\frac{\widehat{p}^{EE*}}{G} - r)(\alpha\widehat{p}^{EE*} - (1-\alpha)hG) & if \quad \underline{r}^{EE} < r \leq \frac{(1+\alpha)}{2} \\ \frac{1+\alpha}{2}G & if \quad r > \frac{(1+\alpha)}{2} \end{cases} \tag{22}$$

The firm's total profit from selling the two products is $\Pi^{EE*} = \pi_1^{EE*} + \pi_2^{EE*} = 2\pi_i^{EE*}$.

We derive type i consumers' total surplus as p_i^{EE*} below:

$$\gamma_i^{EE} = \begin{cases} \alpha(G-p_i) + (1-\alpha)\int_0^1 \beta G - p_i)dF\beta \\ = \frac{(1+\alpha)}{2}G - p_i & if \quad p_i \leq rG \\ \alpha(G-p_i) + (1-\alpha)\int_{\frac{p_i}{G}-r}^1((\beta G - p_i)dF\beta \\ +(1-\alpha)\int_0^{\frac{p_i}{G}-r}(-rG)dF\beta & if \quad rG < p_i \leq (1+r-\frac{r}{\alpha})G \\ = \alpha(G-p_i) + (1-\alpha)(\frac{G^2-2Gp_i+p_i^2-r^2G^2}{2G}) \\ +(1-\alpha)\frac{p_i-rG}{G}(-rG) \end{cases} \tag{23}$$

At the optimal price p_i^{EE*}, the consumer surplus is

$$\begin{aligned} \gamma_i^{EE*} &= \gamma_i^{EE}(p_i^{EE*}) \\ &= \begin{cases} \frac{1-6r(1-\alpha)+r^2(1-\alpha)^2-4\alpha^2+2h(1-\alpha)(1+r(1-\alpha))+h^2(1-\alpha)^2}{8(1-\alpha)}G & if \quad r \leq \underline{r}^{EE} \\ 0 & if \quad \underline{r}^{EE} < r \leq \frac{1+\alpha}{2} \\ \frac{G}{2}(1+\alpha-2r) & if \quad r > \frac{(1+\alpha)}{2}. \end{cases} \end{aligned} \tag{24}$$

The total consumer surplus is $\Gamma^{EE*} = \gamma_1^{EE*} + \gamma_2^{EE*} = 2\gamma_i^{EE*}$. Note that when $r > \frac{(1+\alpha)}{2}$, the total consumer surplus is negative, $\gamma_i^{EE*} = \frac{G}{2}(1+\alpha-2r) < 0$. This is because the high consumer return cost forces consumers to keep a misfit product, which impairs their surplus.

Comparing Maximized Firm Profit in Cases EE, LE/El, and LL

First, we compare the firm's maximized profit in case EE, Π^{EE*}, and in case LE/EL, $\Pi^{LE*} = \Pi^{EL*}$. We consider the following conditions.

(i) $r > \frac{(1+\alpha)}{2}$: this is can be regions C or D in case LE

(i.a) Region C: $\Pi^{LE*} = \frac{G}{4(1-\alpha)} + \frac{G}{4(1-\alpha)} = \Pi^{EL*} > \Pi^{EE*} = (1+\alpha)G$ is never satisfied

(i.b) Region D: $\Pi^{LE*} = \alpha G + rG = \Pi^{EL*} > \Pi^{EE*} = (1+\alpha)G$ is never satisfied.

(ii) $\frac{3-h(1-\alpha)-2\sqrt{2+\alpha^2-2h(1-\alpha)}}{1-\alpha} < r < \frac{1+\alpha}{2}$

(ii.a) $0 < \alpha \leq \frac{1}{2}$: this can be regions B or C in case LE.

Region B: $\Pi^{LE*} > \Pi^{EE*}$ is never satisfied, since $\pi_i^{EE*}(p_i = \frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}}) > \pi_2^{LE*}(p_2 = (1+r-\frac{r}{\alpha})G) > \pi_1^{LE*} = \frac{G}{4(1-\alpha)}$.

Region C: $\Pi^{LE*} = \frac{G}{4(1-\alpha)} + \frac{G}{4(1-\alpha)} = \Pi^{EL*} > \Pi^{EE*}$ is never satisfied.

(ii.b) $\frac{1}{2} < \alpha < 1$; this can be regions B or D in case LE.

Region B: $\Pi^{LE*} = \alpha G + \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G > \Pi^{EE*} = 2\pi_i^{EE*}(p_i = \frac{1+r-r\alpha}{1-\alpha} - \sqrt{\frac{2r-2r\alpha+\alpha^2}{(1-\alpha)^2}})$ is satisfied if r is sufficiently small.

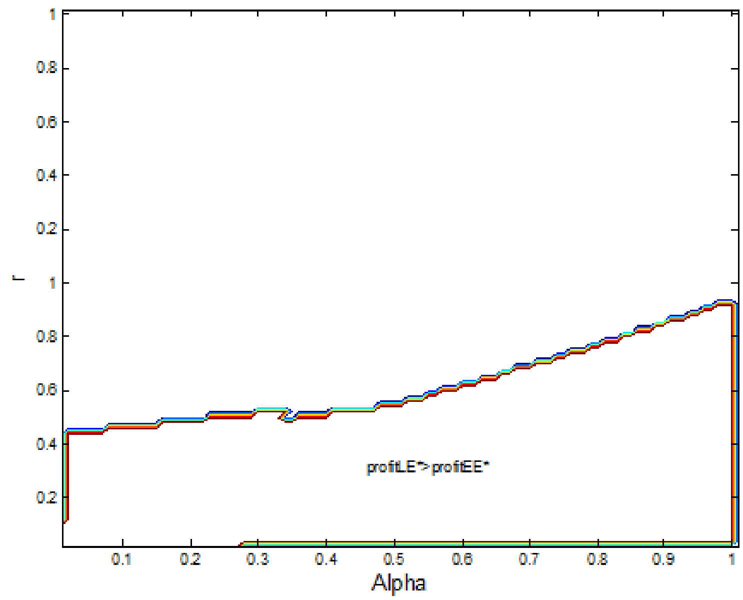

Figure A1: $\pi^{LE*} > \pi^{EE*}$ when consumer return cost is low ($h = 0.4$).

Region D: $\Pi^{LE*} = 2\alpha G = \Pi^{EL*} > \Pi^{EE*}$ is never satisfied.

(iii) $r < p_i^{EE*} = \frac{3-h(1-\alpha)-2\sqrt{2+\alpha^2-2h(1-\alpha)}}{1-\alpha}$: this can be regions A, B, or C in case LE.

(iii.a) Region A: Since $\pi_2^{LE*} = \pi_2^{EE*}$, $\Pi^{LE*} > \Pi^{EE*}$ is satisfied when $\pi_1^{LE*} = \frac{G}{4(1-\alpha)} > \pi_1^{EE*} = \frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-\alpha)(1-r(1-\alpha))}{4(1-\alpha)}G$, that is, when $r < \frac{\sqrt{1+4h(1-\alpha)}-(1+h(1-\alpha))}{1-\alpha}$.

(iii.b) Region B:

When $0 < \alpha \leq \frac{1}{2}$, $\Pi^{LE*} = \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G + \frac{G}{4(1-\alpha)} > \Pi^{EE*} = 2\frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2-2h(1-\alpha)(1-r(1-\alpha))}{4(1-\alpha)}G$ is satisfied if r is sufficiently small.

When $\frac{1}{2} < \alpha < \frac{1+h}{2+h}$, $\Pi^{LE*} = \alpha G + \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G > \Pi^{EE*} = 2\frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2+2h(1-\alpha)(1-r(1-\alpha))}{4(1-\alpha)}G$ is always satisfied.

(iii.c) Region C: $\Pi^{LE*} = \frac{G}{4(1-\alpha)} + \frac{G}{4(1-\alpha)} > \Pi^{EE*} = 2\frac{(1+r(1-\alpha))^2+h^2(1-\alpha)^2+2h(1-\alpha)(1-r(1-\alpha))}{4(1-\alpha)}G$ is never satisfied.

The above analysis suggests that $\Pi^{LE*} > \Pi^{EE*}$ is satisfied when the consumer return cost is r is sufficiently low. Given the complexity of the model, we resort to numerical solutions. Given $h = 0.4$, Figure (A1) shows the region where $\Pi^{LE*} > \Pi^{EE*}$ is satisfied.

We then examine the benefit of firm strategy LE/EL in synergizing the firm's online and offline channels. To demonstrate that the benefit the multi-channel seller enjoys by adopting an omni-channel strategy that facilitates consumer pseudo-showrooming goes beyond the benefits

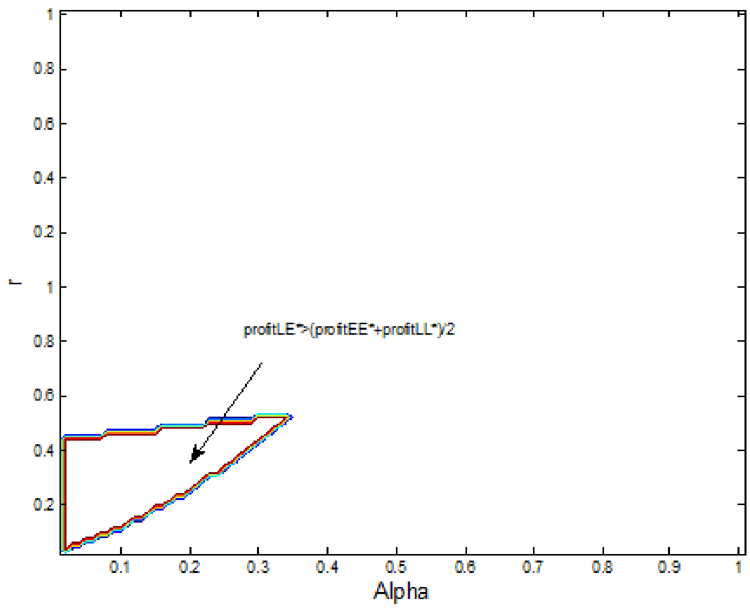

Figure A2: $\pi^{LE*} > (\pi^{LL*} + \pi^{EE*})/2$ when the fit probability of products α is small ($h = 0.4$).

of selling products through a single channel, online or offline, we compare firm's total profit from selling two products under strategy LE/EL, Π^{LE*}, with the total profit of two independent single-product sellers, one selling its product through the pure online channel and obtaining a maximized profit of $\Pi^{EE*}/2$, and the other selling its product through the dual channel and obtains a maximized profit of $\Pi^{LL*}/2$. Figure (A2) shows the region where $\Pi^{LE*} > (\Pi^{EE*} + \Pi^{LL*})/2$ is satisfied ($h = 0.4$).

Proof of Results Regarding Pseudo-Showrooming Assists Consumer Learning about Product Fit

We first solve the firm's optimal pricing Strategy in case LE/EL. Given that the two products are symmetric, we focus on examining case LE. The firm's pricing strategy for product 1, which it sells through the dual channel, is the same as in strategy LL. We examine the firm's pricing strategy for selling product 2, which it offers through the online channel exclusively.

We first examine the case when $r \leq \alpha$ and consider the following conditions.

(i) $p_2 \leq rG$

The firm's profit function for product 2 is $\pi_2^{LE} = \rho(\alpha p_2 + (1-\alpha)(1-\frac{p_2}{G})p_2) + (1-\rho)p_2$. The interior solution can be solved as $p_2^{LE*} = \frac{G}{2\rho(1-\alpha)}$, which sustains only if $r > r_1 = \frac{1}{2\rho(1-\alpha)}$. Note that $\frac{1}{2\rho(1-\alpha)} < 1$ only if $\rho > \frac{1}{2(1-\alpha)}$.

(i.a) If $r > r_1 = \frac{1}{2\rho(1-\alpha)}$, the interior solution $p_2^{LE*} = \frac{G}{2\rho(1-\alpha)}$ constitutes the optimal price, which renders maximized firm profit of $\pi_2^{LE*} = \frac{G}{4\rho(1-\alpha)}$.

(i.b) If $r \leq \frac{1}{2\rho(1-\alpha)}$, the corner solution $p_2^{LE*} = rG$ constitutes the optimal price, which renders a maximized firm profit of $\pi_2^{LE*} = Gr(1 + r(-1+\alpha)\rho)$.

It is easy to see that π_2^{LE*} always decreases with ρ in strategies (i.a) and (i.b).

(ii) $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$

In this case, the firm's profit function for product 2 is $\pi_2^{LE} = \rho(\alpha p_2 + (1-\alpha)(1-\frac{p_2}{G})p_2) + (1-\rho)((1-\frac{p_2}{G}+r)p_2 + (\frac{p_2}{G}-r)\alpha p_2 - hG(\frac{p_2}{G}-r)(1-\alpha))$. The interior solution can be solved as $p_2^{LE*} = \frac{1+(r-h)(1-\alpha)(1-\rho)}{2(1-\alpha)}G$, which sustains if $\{0 < \alpha \leq \frac{1+h(1-\rho)}{2+h(1-\rho)} \& r \leq r_2 = \frac{\alpha(1-2\alpha)+h(1-\alpha)(1-\rho)}{(1-\alpha)(2-\alpha-\alpha\rho)}\}$.

(ii.a) If $\{0 \leq \alpha \leq \frac{1+h(1-\rho)}{2+h(1-\rho)} \& 0 \leq r \leq r_2 = \frac{\alpha(1-2\alpha)+h(1-\alpha)(1-\rho)}{(1-\alpha)(2-\alpha-\alpha\rho)}\}$, the interior solution $p_2^{LE*} = \frac{1+(r-h)(1-\alpha)(1-\rho)}{2(1-\alpha)}G$ constitutes the optimal price, which renders a maximized firm profit of $\pi_2^{LE*} = \frac{(1+r(1-\alpha)(1-\rho))^2+h^2(1-\alpha)^2(1-\rho)^2-2h(1-r(1-\alpha)(1+\rho))(1-\alpha)(1-\rho)}{4(1-\alpha)}$. This profit decreases with ρ if and only if $r > \frac{(-1-2h\rho+2h\alpha\rho)}{2(1-\alpha)(1-\rho)} + \frac{\sqrt{1+4h-4h^2-4h\alpha+8h^2\alpha-4h^2\alpha^2+8h^2\rho-16h^2\alpha\rho+8h^2\alpha^2\rho}}{2(1-\alpha)(1-\rho)}$.

(ii.b) If $\{\alpha > \frac{1+h(1-\rho)}{2+h(1-\rho)}$ or $r > r_2 = \frac{\alpha(1-2\alpha)+h(1-\alpha)(1-\rho)}{(1-\alpha)(2-\alpha-\alpha\rho)}\}$, the corner solution $p_2^{LE*} = (1 + r - \frac{r}{\alpha})G$ constitutes the optimal price, which renders a maximized firm profit of $\pi_2^{LE*} = \frac{(-r^2(1-\alpha)^2(1-\alpha\rho)+r(1-\alpha+h(1-\rho)-\alpha\rho)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha)(1-\rho)))}{\alpha^2}G$. This profit decreases with ρ if $\{0 < \alpha < \frac{1-h}{2-h} \& \frac{h+\alpha}{2(1-\alpha)} - \frac{1}{2(1-\alpha)}\sqrt{h^2-2h\alpha+\alpha^2+4h\alpha^2} < r < \frac{h+\alpha}{2(1-\alpha)} - \frac{1}{2(1-\alpha)}\sqrt{h^2-2h\alpha+\alpha^2+4h\alpha^2}\}$ or $\{\frac{1-h}{2-h} < \alpha < 1 \& r > \frac{h+\alpha}{2(1-\alpha)} - \frac{1}{2(1-\alpha)}\sqrt{h^2-2h\alpha+\alpha^2+4h\alpha^2}\}$.

(iii) $(1 + r - \frac{r}{\alpha})G < p_2 \leq G$

In this case, the firm's profit function for product 2 is $\pi_2^{LE} = \rho(\alpha p_2 + (1-\alpha)(1-\frac{p_2}{G})p_2) + (1-\rho)\frac{G-p_2}{G(1-\alpha)}p_2$. The interior solution can be solved as $p_2^{LE*} = \frac{G(1-\alpha\rho)}{2(1-2\alpha\rho+\alpha^2\rho)}$, which sustains only if $r \geq \frac{(-\alpha+3\alpha^2\rho-2\alpha^3\rho)}{(-2+2\alpha+4\alpha\rho-6\alpha^2\rho+2\alpha^3\rho)}$.

(iii.a) If $r \geq \frac{(-\alpha+3\alpha^2\rho-2\alpha^3\rho)}{(-2+2\alpha+4\alpha\rho-6\alpha^2\rho+2\alpha^3\rho)}$, the interior solution $p_2^{LE*} = \frac{G(1-\alpha\rho)}{2(1-2\alpha\rho+\alpha^2\rho)}$ constitutes the optimal price, which renders a maximized firm profit of $\pi_2^{LE*} = \frac{G(1-\alpha\rho)^2}{4(1-\alpha)(1-2\alpha\rho+\alpha^2\rho)}$. This profit decreases with ρ if $\alpha > \frac{2\rho-1}{\rho}$.

(iii.b) If $r < \frac{(-\alpha+3\alpha^2\rho-2\alpha^3\rho)}{(-2+2\alpha+4\alpha\rho-6\alpha^2\rho+2\alpha^3\rho)}$, the corner solution $p_2^{LE*} = G$ constitutes the optimal price, which renders a maximized firm profit of $\pi_2^{LE*} = \rho\alpha G$. This profit always increases with ρ.

When $r > \alpha$, we consider the following conditions.

(i) $p_2 \leq \alpha G$

In this case, the firm's profit function for product 2 is $\pi_2^{LE} = \rho(\alpha p_2 + (1-\alpha)(1-\frac{p_2}{G})p_2) + (1-\rho)p_2$.

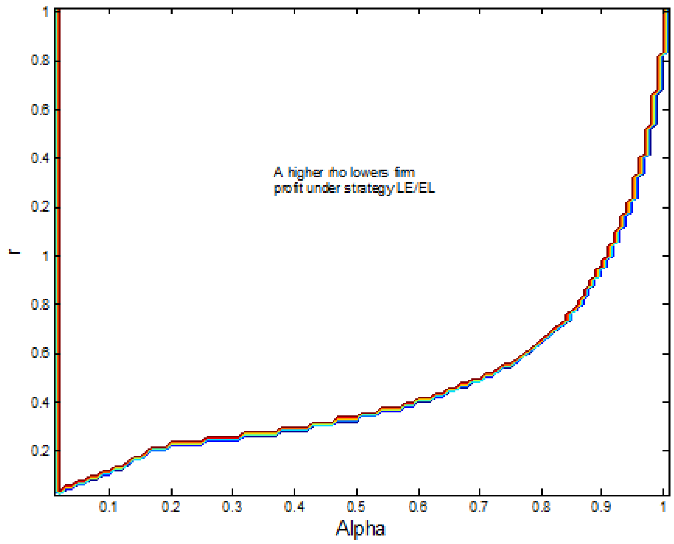

Figure A3: Firm profit under strategy LE/EL decreases with ρ when the consumer return cost r is large.

The interior solution can be solved as $p_2^{LE*} = \frac{G}{2\rho(1-\alpha)}$, which never sustains. Therefore, the corner solution $p_2^{LE*} = \alpha G$ constitutes the optimal price, which renders a maximized firm profit of $\pi_2^{LE*} = G\alpha(1 - \alpha\rho + \alpha^2\rho)$. It is easy to see that π_2^{LE*} always decreases with ρ.

(ii) $\alpha G < p_2 \leq G$

In this case, the firm's profit function for product 2 is $\pi_2^{LE} = \rho(\alpha p_2 + (1-\alpha)(1-\frac{p_2}{G})p_2) + (1-\rho)\frac{G-p_2}{G(1-\alpha)}p_2$. The interior solution can be solved as $p_2^{LE*} = \frac{G(1-\alpha\rho)}{2(1-2\alpha\rho+\alpha^2\rho)}$, which sustains only if $0 < \alpha \leq \frac{1}{2}$ or if $\frac{1}{2} < \alpha \leq 1 \& \frac{1-2\alpha}{\alpha-4\alpha^2+2\alpha^3} < \rho \leq 1$.

(ii.a) If $\{0 < \alpha \leq \frac{1}{2}\} \cup \{\frac{1}{2} < \alpha \leq 1 \& \frac{1-2\alpha}{\alpha-4\alpha^2+2\alpha^3} < \rho \leq 1\}$, the interior solution $p_2^{LE*} = \frac{G(1-\alpha\rho)}{2(1-2\alpha\rho+\alpha^2\rho)}$ constitutes the optimal price, which renders a maximized firm profit of

$\pi_2^{LE*} = \frac{G(1-\alpha\rho)^2}{4(1-\alpha)(1-2\alpha\rho+\alpha^2\rho)}$. This profit decreases with ρ if $\frac{2\rho-1}{\rho} < \alpha < \alpha_1$ and increases with ρ otherwise.

(ii.b) If $\{\frac{1}{2} < \alpha \leq 1 \& 0 < \rho \leq \frac{1-2\alpha}{\alpha-4\alpha^2+2\alpha^3}\}$, the corner solution $p_2^{LE*} = G$ constitutes the optimal price, and renders a maximized firm profit of $\pi_2^{LE*} = \rho\alpha G$. This profit increases with ρ.

Summarizing the above analysis, we obtain that π_2^{LE*} decreases with ρ if the consumer return cost r is sufficiently large. Given the complexity of the model, we resort to numerical solution. Figure (A3) depicts the region where π_2^{LE*} decreases with ρ at $h = 0.1$ and $\rho = 0.3$.

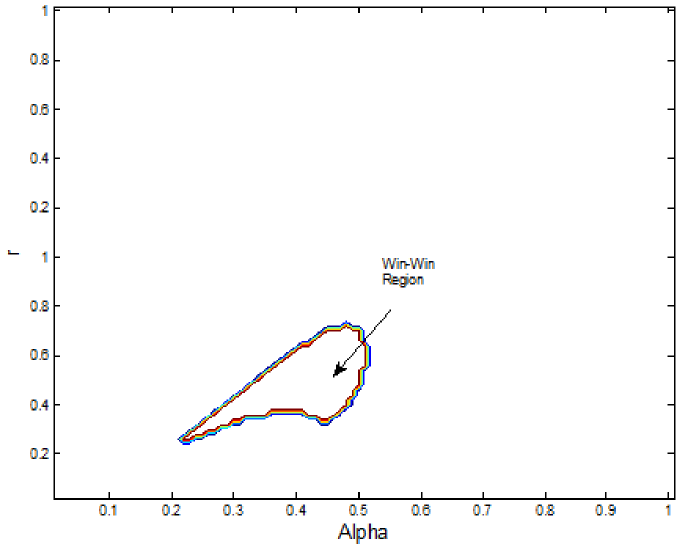

Figure A4: Win-Win Region When $\rho = 0.3$ and $h = 0.1$.

Given p_2, type 2 consumers' total surplus can be derived as

$$\gamma_2^{LE}(p_2) = \begin{cases} \begin{array}{c} \rho(\alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2}{G}}^{1}(\beta G - p_2)dF\beta) + \\ (1-\rho)(\alpha(G-p_2) + (1-\alpha)\int_0^1(\beta G - p_2)dF\beta) \\ = \rho(\alpha(G-p_2) + (1-\alpha)\frac{(G-p_2)^2}{2G}) + \\ (1-\rho)(\frac{(1+\alpha)}{2}G - p_2) \end{array} & if & \begin{array}{c} \{r \leq \alpha \& p_2 \leq rG\} \\ \text{or } \{r > \alpha \& p_2 \leq \alpha G\} \end{array} \\ \begin{array}{c} \rho(\alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2}{G}}^{1}(\beta G - p_2)dF\beta) + \\ (1-\rho)(\alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2}{G}-r}^{1}(\beta G - p_2)dF\beta + \\ (1-\alpha)\int_0^{\frac{p_2}{G}-r}(-rG)dF\beta) \\ = \rho(\alpha(G-p_2) + (1-\rho)(\alpha(G-p_2) + \\ (1-\alpha)(\frac{G^2-2Gp_2+p_2^2-r^2G^2}{2G}) + (1-\alpha)\frac{p_2-rG}{G}(-rG)) \end{array} & if & \begin{array}{c} r < \alpha \\ \& rG < p_2 \leq (1+r-\frac{r}{\alpha})G \end{array} \\ \begin{array}{c} \rho(\alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2}{G}}^{1}(\beta G - p_2)dF\beta) + \\ (1-\rho)(\alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2-G\alpha}{G-G\alpha}}^{1}(\beta G - p_2)dF\beta) \\ = \rho(\alpha(G-p_2) + (1-\rho)((G-p_2)\alpha + \frac{(G-p_2)^2(1-2\alpha)}{2G(1-\alpha)}) \end{array} & if & \begin{array}{c} \{r < \alpha \\ \& (1+r-\frac{r}{\alpha})G \leq p_2 \leq G\} \\ \text{or } r \geq \alpha \& p_2 \geq \alpha G \end{array} \end{cases} \quad (25)$$

Figure (A4) illustrates the win-win region where the firm's product placement strategy LE/EL generates a greater firm profit as well as a greater consumer surplus than its strategy LL, $\Pi^{LE*} > \Pi^{LL*}$ and $\Gamma^{LE*} > \Gamma^{LL*}$ (when $\rho = 0.3$ and $h = 0.1$).

Proof of Results Regarding Demand Overlap between the Two Products

We consider the case when the demand for the two products fully overlap. We assume that an individual consumer may buy either product that offers a greater non-negative utility, that is, there is no difference between type 1 and type 2 consumers. A consumer's perceived fits with the two products are independent. As a result, among the two units of mass of consumers, a proportion α^2 perceive true good fit with both products, and have utilities of $U_1 = G - p_1$ and $U_2 = G - p_2$ from buying products 1 and 2, respectively. A proportion $\alpha(1-\alpha)$ of consumers perceive true good fit with product 1 only, and have utilities of $U_1 = G - p_1$ and $U_2 = \beta G - p_2$; a proportion $(1-\alpha)\alpha$ of consumers perceive true good fit with product 2 only, and have utilities of $U_1 = \beta G - p_1$ and $U_2 = G - p_2$; and the remaining proportion $(1-\alpha)^2$ of consumers perceive true good fit with neither product and have utilities of $U_1 = \beta G - p_1$ and $U_2 = \beta G - p_2$. Other specifications in the main model apply.

Firm Sells Both Products Through the Dual Channel (Case LL)

A consumer who perceives a good fit with both products will buy product 1 if and only if $U_1 > U_2$, which is satisfied when $p_1 < p_2 \& p_1 \le G$; a consumer who perceives a good fit only with product 1 will buy product 1 if and only if $\beta < 1 - \frac{p_1 - p_2}{G}$; consumers who perceive a good fit only with product 2 will buy product 1 if and only if $\beta > \max\{1 + \frac{p_1 - p_2}{G}, \frac{p_1}{G}\} = 1 + \frac{p_1 - p_2}{G}$; consumers who perceive a good fit with neither product will buy product 1 if and only if $p_1 < p_2 \& \beta \ge \frac{p_1}{G}$. We summarize the consumer demand for product $i (i = 1, 2; j = 1, 2, j \ne i)$ as

$$D_i = \begin{cases} 2(\alpha^2 + \alpha(1-\alpha) + \alpha(1-\alpha)\frac{p_j - p_i}{G} + (1-\alpha)^2(1 - \frac{p_i}{G})) & if \quad p_i < p_j \\ 2(\frac{\alpha^2}{2} + \alpha(1-\alpha) + \frac{(1-\alpha)^2}{2}(1 - \frac{p_i}{G})) & if \quad p_i = p_j \\ 2(\alpha(1-\alpha)(1 - \frac{p_i - p_j}{G})) & if \quad p_i > p_j \end{cases} \tag{26}$$

The firm maximizes its total profit of $\Pi^{LL} = D_1^{LL} p_1 + D_2^{LL} p_2$. We consider the following possible firm pricing strategies.

(i) First, we consider the case when the firm sets the same price for the two products, $p_1 = p_2 = p$. Given p, the firm's profit from selling product i is $\pi_i^{LL} = 2(\frac{\alpha^2}{2} + \alpha(1-\alpha) + \frac{(1-\alpha)^2}{2}(1 - \frac{p}{G}))p$. The interior solution can be solved as $p^{LL*} = \frac{G}{2(1-\alpha)^2}$, which renders a maximized firm profit of $\pi_i^{LL*} = \frac{G}{4(1-\alpha)^2} G$; note that this price sustains ($p^{LL*} \le G$) only if $0 < \alpha \le 1 - \frac{\sqrt{2}}{2} \cong 0.29$.

Otherwise, if $\alpha > 1-\frac{\sqrt{2}}{2}$, the corner solution $p^{LL*} = G$ constitutes the optimal price, which renders a maximized firm profit of $\pi_i^{LL*} = (2-\alpha)\alpha G$.

We summarize the firm's optimal price for selling product $i(i = 1, 2)$ as

$$p_i^{LL*} = \begin{cases} \frac{G}{2(1-\alpha)^2} & if \quad 0 < \alpha \le 1-\frac{\sqrt{2}}{2} \cong 0.29 \\ G & if \quad 1-\frac{\sqrt{2}}{2} < \alpha \le 1 \end{cases} \tag{27}$$

and the firm's maximized profit from selling product i is

$$\pi_i^{LL*} = \begin{cases} \frac{G}{2(1-\alpha)^2} & if \quad 0 < \alpha \le 1-\frac{\sqrt{2}}{2} \\ (2-\alpha)\alpha G & if \quad 1-\frac{\sqrt{2}}{2} < \alpha \le 1 \end{cases} \tag{28}$$

The total firm profit is thus

$$\begin{aligned} \Pi^{LL*} &= \pi_1^{LL*} + \pi_2^{LL*} \\ &= \begin{cases} \frac{G}{(1-\alpha)^2} & if \quad 0 < \alpha \le 1-\frac{\sqrt{2}}{2} \\ 2(2-\alpha)\alpha G & if \quad 1-\frac{\sqrt{2}}{2} < \alpha \le 1 \end{cases} \end{aligned} \tag{29}$$

Type i consumers' surplus can be derived as

$$\begin{aligned} \gamma_i^{LL}(p_i) &= 2(\frac{\alpha^2}{2} + \alpha(1-\alpha))(G-p_i) + \frac{(1-\alpha)^2}{2}\int_{\frac{p_i}{G}}^{1}(\beta G - p_i)dF\beta \\ &= 2((\frac{\alpha^2}{2} + \alpha(1-\alpha))(G-p_i) + \frac{(1-\alpha)^2}{2}(\frac{G}{2} - p_i + \frac{p_i^2}{2G})). \end{aligned} \tag{30}$$

Given the optimal price p_i^{LL*}, we have

$$\gamma_i^{LL*} = \gamma_i^{LL}(p_i^{LL*}) = \begin{cases} \frac{(1-16\alpha^2+16\alpha^3-4\alpha^4)}{8(1-\alpha)^2}G & if \quad 0 < \alpha \le 1-\frac{\sqrt{2}}{2} \\ 0 & if \quad 1-\frac{\sqrt{2}}{2} < \alpha \le 1 \end{cases} \tag{31}$$

The total consumer surplus is thus

$$\begin{aligned} \Gamma^{LL*} &= \gamma_1^{LL*} + \gamma_2^{LL*} \\ &= \begin{cases} \frac{(1-16\alpha^2+16\alpha^3-4\alpha^4)}{4(1-\alpha)^2}G & if \quad 0 < \alpha \le 1-\frac{\sqrt{2}}{2} \\ 0 & if \quad 1-\frac{\sqrt{2}}{2} < \alpha \le 1 \end{cases} \end{aligned} \tag{32}$$

(ii) Second, we consider the case when the firm charges different prices for the two products. Without loss of generality, we assume $p_1 < p_2$. The firm's profit function is thus

$$\Pi^{LL} = 2(\alpha^2 + \alpha(1-\alpha) + \alpha(1-\alpha)\frac{p_2-p_1}{G} + (1-\alpha)^2(1-\frac{p_1}{G}))p_1 + \alpha(1-\alpha)(1-\frac{p_2-p_1}{G})p_2 \tag{33}$$

The interior solution can be solved as $\{p_1^{LL*} = \frac{G}{2(1-\alpha)^2}, p_2^{LL*} = \frac{G}{2(1-\alpha)^2} + \frac{G}{2}\}$. This strategy, however, does not satisfy $p_2^{LL*} \le G$. A corner solution can be solved as $\{p_1^{LL*} = \frac{G(1+\alpha-\alpha^2)}{2(1-\alpha)}, p_2^{LL*} = G\}$, which satisfies $p_1^{LL*} \leq G$ if $0 \leq \alpha \leq \frac{3-\sqrt{5}}{2} \cong 0.38$, and renders a profit of $\Pi^{LL*} = G\frac{(1+\alpha-\alpha^2)^2}{2(1-\alpha)}$. At this equilibrium price, consumers' total surplus is

$$\begin{aligned}\Gamma^{LL}(p_1, p_2) &= 2((\alpha^2 + \alpha(1-\alpha))(G-p_1) + (1-\alpha)^2 \int_{\frac{p_1}{G}}^{1} (\beta G - p_1) dF\beta + \\ &\quad \alpha(1-\alpha)(1 - \frac{p_2 - p_1}{G})(G - p_2)) \\ &= 2((\alpha^2 + \alpha(1-\alpha))(G-p_1) + (1-\alpha)^2(\frac{G}{2} - p_1 + \frac{p_1^2}{2G}) + \\ &\quad \alpha(1-\alpha)(1 - \frac{p_2 - p_1}{G})(G - p_2)) \end{aligned} \tag{34}$$

At $\{p_1^{LL*} = \frac{G(1+\alpha-\alpha^2)}{2(1-\alpha)}, p_2^{LL*} = G\}$, consumers' total surplus can be derived as

$$\Gamma^{LL*} = \Gamma^{LL}(p_1^{LL*}, p_2^{LL*}) = \frac{(1 - 3\alpha + 5\alpha^2 - 13\alpha^3 + 7\alpha^4 - \alpha^5)}{4(1-\alpha)} G \tag{35}$$

Comparing firm's strategies (i) and (ii), we summarize the firm's optimal prices and maximized profit as

$$\begin{cases} p_1^{LL*} = p_2^{LL*} = \frac{G}{2(1-\alpha)^2} & if \quad 0 < \alpha \leq 1 - \frac{\sqrt{2}}{2} \cong 0.29 \\ p_1^{LL*} = \frac{(1+\alpha-\alpha^2)}{2(1-\alpha)} G, p_2^{LL*} = G & if \quad 1 - \frac{\sqrt{2}}{2} < \alpha \leq \frac{3-\sqrt{5}}{2} \\ p_1^{LL*} = p_2^{LL*} = G & if \quad \frac{3-\sqrt{5}}{2} < \alpha \leq 1 \end{cases} \tag{36}$$

and

$$\Pi^{LL*} = \begin{cases} \frac{G}{(1-\alpha)^2} & if \quad 0 < \alpha \leq 1 - \frac{\sqrt{2}}{2} \cong 0.29 \\ \frac{(1+\alpha-\alpha^2)^2 G}{2(1-\alpha)} & if \quad 1 - \frac{\sqrt{2}}{2} < \alpha \leq \frac{3-\sqrt{5}}{2} \\ 2(2-\alpha)\alpha G & if \quad \frac{3-\sqrt{5}}{2} < \alpha \leq 1 \end{cases} \tag{37}$$

At the equilibrium prices, $\{p_1^{LL*}, p_2^{LL*}\}$, the total consumer surplus is

$$\Gamma^{LL*} = \begin{cases} \frac{(1-16\alpha^2+16\alpha^3-4\alpha^4)G}{4(1-\alpha)^2} & if \quad 0 < \alpha \leq 1 - \frac{\sqrt{2}}{2} \cong 0.29 \\ \frac{(1-3\alpha+5\alpha^2-13\alpha^3+7\alpha^4-\alpha^5)G}{4(1-\alpha)} & if \quad 1 - \frac{\sqrt{2}}{2} < \alpha \leq \frac{3-\sqrt{5}}{2} \\ 0 & if \quad \frac{3-\sqrt{5}}{2} < \alpha \leq 1 \end{cases} \tag{38}$$

Firm Sells One Product Through the Online Channel Exclusively (Case LE/EL)

Since the two products are symmetric we focus on examining the firm's optimal pricing strategies in case LE.

Stage 3: Consumer Purchase Decisions

We first consider consumers (a proportion α and a size 2α) who find a good fit with product 1 after inspection. These consumers' utilities from buying product 1 and product 2 are respectively

$$U_1 = G - p_1 \text{ and} \tag{39}$$

$$EU_2 = \begin{cases} \alpha G + (1-\alpha)\beta G - p_2 & if \quad \beta \geq \frac{p_2}{G} - r \\ \alpha G - (1-\alpha) r G - \alpha p_2 & if \quad \beta < \frac{p_2}{G} - r \end{cases} \tag{40}$$

To facilitate analysis, we denote the proportion of consumers who buy product 1 with θ_1, the proportion of consumers who buy product 2 and keep it with θ_2, and the proportion of consumers who buy product 2 but later return it with θ_3 ($0 \leq \theta_1, \theta_2, \theta_3 \leq 1,$ and $\theta_1 + \theta_2 + \theta_3 = 1$).

These consumers will buy product 1 if $U_1 > U_2$, which is satisfied if $\{\frac{p_2}{G} - r \leq \beta < 1 - \frac{p_1 - p_2}{G(1-\alpha)}\}$ or if $\{p_1 < p_2\alpha + G(1+r)(1-\alpha) \& \beta < \frac{p_2}{G} - r\}$. Also note that $\frac{p_2}{G} - r \leq \beta < 1 - \frac{p_1-p_2}{G(1-\alpha)}$ can be satisfied only if $p_1 < p_2\alpha + G(1+r)(1-\alpha)$. Therefore, demand exists for product 1 only if its price is sufficiently low, $p_1 < p_2\alpha + G(1+r)(1-\alpha)$, in which case, $\theta_1 = 1 - \frac{p_1-p_2}{G(1-\alpha)}$ and $\theta_2 = \frac{p_1-p_2}{G(1-\alpha)}$. We derive the consumer demand condition in the following cases.

(i) $p_1 \geq p_2\alpha + G(1+r)(1-\alpha)$: $\theta_1 = 0$; and θ_2 can be derived similar as in the main model, following equations (14) and (15).

(ii) $p_1 \leq p_2$: $\theta_1 = 1$ and $\theta_2 = 0$.

(iii) $p_2 \leq p_1 < p_2\alpha + G(1+r)(1-\alpha)$: we further consider the following cases.

If $r \leq \alpha$

(iii.a) $p_2 \leq rG$: $\theta_1 = 1 - \frac{p_1-p_2}{G(1-\alpha)}$, $\theta_2 = \frac{p_1-p_2}{G(1-\alpha)}$, and $\theta_3 = 0$.

(iii.b) $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$: in this case, consumers will return product 2 if $\beta < \frac{p_2}{G} - r$. Since $\frac{p_2}{G} - r < 1 - \frac{p_1-p_2}{G(1-\alpha)}$ is always satisfied, we have $\theta_1 = 1 - \frac{p_1-p_2}{G(1-\alpha)}$, $\theta_2 = \frac{p_1-p_2}{G(1-\alpha)}$, and and $\theta_3 = 0$.

(iii.c) $p_2 > 1 + r - \frac{r}{\alpha}$: in this case, consumers will buy product 2 only if $\beta > 1 - \frac{G-p_2}{G(1-\alpha)}$. Since $1 - \frac{G-p_2}{G(1-\alpha)} < 1 - \frac{p_1-p_2}{G(1-\alpha)}$ is always satisfied, we have $\theta_1 = 1 - \frac{p_1-p_2}{G(1-\alpha)}$, $\theta_2 = \frac{p_1-p_2}{G(1-\alpha)}$, and $\theta_3 = 0$.

If $r > \alpha$

(iii.d) $p_2 \leq \alpha G$: $\theta_1 = 1 - \frac{p_1-p_2}{G(1-\alpha)}$, $\theta_2 = \frac{p_1-p_2}{G(1-\alpha)}$, and $\theta_3 = 0$.

(iii.e) $p_2 > \alpha G$: in this case, consumers will buy product 2 only if $\beta > 1 - \frac{G-p_2}{G(1-\alpha)}$. Since $1 - \frac{G-p_2}{G(1-\alpha)} < 1 - \frac{p_1-p_2}{G(1-\alpha)}$ is always satisfied, we have $\theta_1 = 1 - \frac{p_1-p_2}{G(1-\alpha)}$, $\theta_2 = \frac{p_1-p_2}{G(1-\alpha)}$, and $\theta_3 = 0$.

We summarize demand conditions among consumers who find a good fit with product 1 in Table A4.

Table A4. Demand Condition Among Consumers Who Find a Good Fit With Product

	$\{r \leq \alpha \& p_2 \leq rG\}$ or $\{r > \alpha \& p_2 \leq \alpha G\}$	$r \leq \alpha \&$ $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$	$\{r \leq \alpha \&$ $p_2 > (1 + r - \frac{r}{\alpha})G\}$ or $\{r > \alpha \& p_2 > \alpha G\}$
$p_1 \geq p_2\alpha + G(1+r)\alpha$	$\theta_1 = 0$ $\theta_2 = 1$ $\theta_3 = 0$	$\theta_1 = 0$ $\theta_2 = (1 + r - \frac{p_2}{G})$ $+(\frac{p_2}{G} - r)\alpha$ $\theta_3 = (\frac{p_2}{G} - r)(1 - \alpha)$	$\theta_1 = 0$ $\theta_2 = \frac{G - p_2}{G(1-\alpha)}$ $\theta_3 = 0$
$p_2 \leq p_1$ $< p_2\alpha + G(1+r)\alpha$	$\theta_1 = 1 - \frac{p_1 - p_2}{G(1-\alpha)}$ $\theta_2 = \frac{p_1 - p_2}{G(1-\alpha)}$ $\theta_3 = 0$	$\theta_1 = 1 - \frac{p_1 - p_2}{G(1-\alpha)}$ $\theta_2 = \frac{p_1 - p_2}{G(1-\alpha)}$ $\theta_3 = 0$	$\theta_1 = 1 - \frac{p_1 - p_2}{G(1-\alpha)}$ $\theta_2 = \frac{p_1 - p_2}{G(1-\alpha)}$ $\theta_3 = 0$
$p_1 \leq p_2$	$\theta_1 = 1$ $\theta_2 = 0$ $\theta_3 = 0$	$\theta_1 = 1$ $\theta_2 = 0$ $\theta_3 = 0$	$\theta_1 = 1$ $\theta_2 = 0$ $\theta_3 = 0$

The total demand for products 1 and 2 from these consumers are $D_1^\theta = 2\alpha\theta_1$ and $D_2^\theta = 2\alpha\theta_2$, and the firm's total profit from these consumers is $\pi^\theta = 2\alpha\theta_1 p_1 + 2\alpha\theta_2 p_2 - 2\alpha\theta_3 hG$.

Next, we consider consumers who find a bad fit with product 1 (a proportion of $1-\alpha$ and a size of $2(1-\alpha)$). These consumers' utilities from buying products 1 and 2 are respectively

$$U_1 = \beta G - p_1 \text{ and} \tag{41}$$

$$EU_2 = \begin{cases} \alpha G + (1-\alpha)\beta G - p_2 & if \quad \beta \geq \frac{p_2}{G} - r \\ \alpha G - (1-\alpha) rG - \alpha p_2 & if \quad \beta < \frac{p_2}{G} - r \end{cases} \tag{42}$$

To facilitate analysis, we denote the proportion of these consumers who buy product 1 with ϕ_1, the proportion of who buy product 2 and keep it with ϕ_2, and the proportion who buy product 2 but later return it with ϕ_3 ($0 \leq \phi_1, \phi_2, \phi_3 \leq 1$, and $\phi_1 + \phi_2 + \phi_3 = 1$).

These consumers will buy product 1 if $U_1 > U_2$, which is satisfied if $\{\beta > \max\{1 - \frac{p_2 - p_1}{\alpha G}, \frac{p_2}{G} - r\}\}$, or if $\{\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)) < \beta \leq \frac{p_2}{G} - r\}$. Note that $1 - \frac{p_2 - p_1}{\alpha G} < \frac{p_2}{G} - r$ is satisfied if $p_1 < p_2(1+\alpha) - (1+r)\alpha G$; and $\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)) < \beta \leq \frac{p_2}{G} - r$ can be satisfied only if $p_1 < p_2(1+\alpha) - (1+r)\alpha G$.

Therefore, if $p_1 < p_2(1+\alpha) - (1+r)\alpha G(< p_2)$, $U_1 > U_2$ is satisfied when $\beta > \frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha))$, in which case $\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$. Otherwise, if $p_1 \geq p_2(1+\alpha) - (1+r)\alpha G$, $U_1 > U_2$ is satisfied when $\beta > 1 - \frac{p_2 - p_1}{\alpha G}$, in which case $\phi_1 = \frac{p_2 - p_1}{\alpha G}$. We derive the consumer demand conditions in the following cases.

(i) $p_1 \geq p_2$: $\phi_1 = 0$, and ϕ_2 can be derived similar as in the main model, following equations (14) and (15).

(ii) $p_2(1+\alpha) - (1+r)\alpha G \leq p_1 \leq p_2$: we further consider the following conditions.

<u>if $r \leq \alpha$</u>

(ii.a) $p_2 \leq rG$: $\phi_1 = \frac{p_2 - p_1}{\alpha G}$, $\phi_2 = 1 - \frac{p_2 - p_1}{\alpha G}$, and $\phi_2 = 0$.

(ii.b) $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$: in this case, consumers will return product 2 if $\beta < \frac{p_2}{G} - r$. Note that in this case $\frac{p_2}{G} - r < 1 - \frac{p_2 - p_1}{\alpha G}$ is always satisfied; therefore, we have $\phi_1 = \frac{p_2 - p_1}{\alpha G}$, $\phi_2 = (1 - \frac{p_2 - p_1}{\alpha G} - (\frac{p_2}{G} - r)) + (\frac{p_2}{G} - r)\alpha$, and $\phi_3 = (\frac{p_2}{G} - r)(1-\alpha)$.

(ii.c) $p_2 > (1 + r - \frac{r}{\alpha})G$: in this case, consumers will buy product 2 only if $\beta > 1 - \frac{G - p_2}{G(1-\alpha)}$. $1 - \frac{G - p_2}{G(1-\alpha)} < 1 - \frac{p_2 - p_1}{\alpha G}$ is satisfied if $p_1 < \frac{G\alpha - p_2}{1-\alpha}$, in which case, $\phi_1 = \frac{p_2 - p_1}{\alpha G}$, $\phi_2 = (1 - \frac{p_2 - p_1}{\alpha G}) - (1 - \frac{G - p_2}{G(1-\alpha)}) = \frac{G - p_2}{G(1-\alpha)} - \frac{p_2 - p_1}{\alpha G}$, and $\phi_3 = 0$. On the other hand, if $p_1 \geq \frac{G\alpha - p_2}{1-\alpha}$, $\phi_1 = 1 - \frac{p_1}{G}$, $\phi_2 = 0$, and $\phi_3 = 0$.

<u>If $r > \alpha$</u>

(ii.d) $p_2 \leq \alpha G$: this case is the same as case (ii.a).

(ii.e) $p_2 > \alpha G$: This case is the same as case (ii.c).

(iii) $p_1 < p_2(1+\alpha) - (1+r)\alpha G$: we further consider the following conditions.

<u>if $r \leq \alpha$</u>

(iii.a) $p_2 \leq rG$: $\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$, $\phi_2 = (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$, and $\phi_3 = 0$.

(iii.b) $rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$, in this case, consumers will return product 2 if $\beta < \frac{p_2}{G} - r$. $\frac{p_2}{G} - r > (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$ is satisfied for $p_1 < p_2(1+\alpha) - (1+r)\alpha G$. Therefore, $\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$ and $\phi_2 = (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))\alpha$, and $\phi_2 = (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))(1-\alpha)$.

(iii.c) $p_2 > (1 + r - \frac{r}{\alpha})G$: In this case, consumers will buy product 2 only if $\beta > 1 - \frac{G - p_2}{G(1-\alpha)}$. If $p_1 < \frac{p_2(1+\alpha-\alpha^2) + G(r(1-\alpha)^2 + (-2+\alpha)\alpha)}{1-\alpha}$, $1 - \frac{G - p_2}{G(1-\alpha)} < (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$ is satisfied, and then $\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$, $\phi_2 = (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha))) - (1 - \frac{G - p_2}{G(1-\alpha)})$, $\phi_2 = 0$. Otherwise, if $p_1 > \frac{p_2(1+\alpha-\alpha^2) + G(r(1-\alpha)^2 + (-2+\alpha)\alpha)}{1-\alpha}$, we have $\phi_1 = 1 - \frac{p_1}{G}$, $\phi_2 = 0$, and $\phi_3 = 0$.

<u>If $r > \alpha$</u>

(iii.d) $p_2 \leq \alpha G$: This case is the same as case (iii.a).

(iii.e) $p_2 > \alpha G$: This case is the same as case (iii.c).

We summarize the demand conditions among consumers who find a bad fit with product 1 in Table A5.

Table A5. Demand Condition Among Consumers Who Find a Bad Fit With Product 1

	$\{r \leq \alpha \& p_2 \leq rG\}$ or $\{r > \alpha \& p_2 \leq \alpha G\}$	$r \leq \alpha \& rG < p_2 \leq (1 + r - \frac{r}{\alpha})G$
$p_1 \geq p_2$	$\phi_1 = 0$ $\phi_2 = 1$ $\phi_3 = 0$	$\phi_1 = 0$ $\phi_2 = (1 + r - \frac{p_2}{G}) + (\frac{p_2}{G} - r)\alpha$ $\phi_3 = (\frac{p_2}{G} - r)(1 - \alpha)$
$p_2(1+\alpha)$ $-G(1+r)\alpha$ $\leq p_1 \leq p_2$	$\phi_1 = \frac{p_2 - p_1}{\alpha G}$ $\phi_2 = (1 - \frac{p_2 - p_1}{\alpha G})$ $\phi_3 = 0$	$\phi_1 = \frac{p_2 - p_1}{\alpha G}$ $\phi_2 = (1 + r - \frac{p_2}{G} - \frac{p_2 - p_1}{\alpha G}) + (\frac{p_2}{G} - r)\alpha$ $\phi_3 = (\frac{p_2}{G} - r)(1 - \alpha)$
$p_1 < p_2(1+\alpha)$ $-G(1+r)\alpha$	$\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$ $\phi_2 = \frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha))$ $\phi_3 = 0$	$\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$ $\phi_2 = \frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha))$ $\phi_3 = 0$

Table A5. (Continued)

	$\{r \leq \alpha \& p_2 > (1+r-\frac{r}{\alpha})G\}$ or $\{r > \alpha \& p_2 > \alpha G\}$
$p_1 \geq p_2$	$\phi_1 = 0$ $\phi_2 = \frac{G-p_2}{G(1-\alpha)}$ $\phi_3 = 0$
$p_2(1+\alpha) - G(1+r)\alpha$ $\leq p_1 \leq p_2$	If $p_1 \leq \frac{G\alpha - p_2}{1-\alpha}$ If $p_1 > \frac{G\alpha - p_2}{1-\alpha}$ $\phi_1 = \frac{p_2 - p_1}{\alpha G}$ $\phi_1 = 1 - \frac{p_1}{G}$ $\phi_2 = \frac{G-p_2}{G(1-\alpha)} - \frac{p_2-p_1}{\alpha G}$ $\phi_2 = 0$ $\phi_3 = 0$ $\phi_3 = 0$
$p_1 < p_2(1+\alpha)-$ $G(1+r)\alpha$	If $p_1 \leq \frac{p_2(1+\alpha-\alpha^2)+G(r(1-\alpha)^2+(-2+\alpha)\alpha)}{1-\alpha}$ $\phi_1 = 1 - (\frac{p_1 - p_2\alpha}{G} + (\alpha - r(1-\alpha)))$ $\phi_2 = (\frac{p_1-p_2\alpha}{G} + (\alpha - r(1-\alpha)))-$ $(1 - \frac{G-p_2}{G(1-\alpha)})$ $\phi_3 = 0$ If $p_1 > \frac{p_2(1+\alpha-\alpha^2)+G(r(1-\alpha)^2+(-2+\alpha)\alpha)}{1-\alpha}$ $\phi_1 = 1 - \frac{p_1}{G}$ $\phi_2 = 0$ $\phi_3 = 0$

The total demand for products 1 and 2 from these consumers are $D_1^\phi = 2(1-\alpha)\phi_1$ and $D_2^\phi = 2(1-\alpha)\phi_2$, and the firm's total profit from these consumers is $\pi^\phi = 2(1-\alpha)\phi_1 p_1 + 2(1-\alpha)\phi_2 - 2(1-\alpha)\phi_3 hG$.

Stage 2: Firm Optimal Pricing Strategies

Among the size 2α of consumers who find a good fit with product 1, the total demand for products 1 and 2 from these consumers are $D_1^\theta = 2\alpha\theta_1$ and $D_2^\theta = 2\alpha\theta_2$, and the firm's total profit from these consumers is $\pi^\theta = 2\alpha\theta_1 p_1 + 2\alpha\theta_2 p_2 - 2\alpha\theta_3 hG$. From the Table 5, it can be seen that given product 2's price ($p_2 \leq rG$, $rG < p_2 \leq (1+r-\frac{r}{\alpha})G$, or $p_2 > (1+r-\frac{r}{\alpha})G$), setting product 1's price lower than that of product 2 ($p_1 < p_2$) is never a dominant strategy because this strategy does not bring any additional demand. Moreover, setting product 1's price too high, $p_1 > p_2\alpha + G(1+r)\alpha$, is not profitable either as it drives all consumers away from product 1 and results in zero profit for product 1. That is, $p_2 \leq p_1 < p_2\alpha + G(1+r)\alpha$ is the dominant strategy to sell to these consumers.

Among the size $2(1-\alpha)$ of consumers who find a bad fit with product 1, the total demand for products 1 and 2 from these consumers are $D_1^{\phi} = 2(1-\alpha)\phi_1$ and $D_2^{\phi} = 2(1-\alpha)\phi_2$, and the firm's total profit from these consumers is $\pi^{\phi} = 2(1-\alpha)\phi_1 p_1 + 2(1-\alpha)\phi_2 - 2(1-\alpha)\phi_3 hG$. From Table 6, it can be proved that strategy $p_2(1+\alpha) - G(1+r)\alpha \leq p_1 < p_2$ always dominates strategy $p_1 < p_2(1+\alpha) - G(1+r)\alpha$, since the former strategy induces the same demand and charges a higher price for product 1. Moreover, strategy $p_1 \geq p_2$ always dominates strategy $p_2(1+\alpha) - G(1+r)\alpha \leq p_1 < p_2$, since the former strategy induces more consumers to buy product 2 without hurting the total demand.

Therefore, the firm's optimal strategy to maximize its total profit of $\Pi^{LE} = \pi^{\theta} + \pi^{\phi}$ is to set $p_2^{LE*} \leq p_1^{LE*} < p_2^{LE*}\alpha + G(1+r)\alpha$. Note that $p_2 < p_2\alpha + G(1+r)\alpha$ can be satisfied only if $p_2 < \frac{(1+r)\alpha}{1-\alpha}G$. We solve the firm's optimal pricing strategies in the following conditions.

If $r \leq \alpha$

(i) $p_2 \leq rG$

In this case, the profit function is $\Pi^{LE} = 2\alpha((1 - \frac{p_1 - p_2}{G(1-\alpha)})p_1 + \frac{p_1 - p_2}{G(1-\alpha)}p_2) + 2(1-\alpha)p_2$. It can be proved that $\partial\Pi^{LE}/\partial p_2 = \frac{2(G(1-\alpha)^2 + 2(p_1 - p_2)\alpha)}{G(1-\alpha)} > 0$ is always satisfied. Therefore, the optimal price is $p_2^{LE*} = rG$. Note that $rG < \frac{(1+r)\alpha}{1-\alpha}G$ can be satisfied only if $\frac{r}{1+2r} < \alpha < 1$; otherwise, the only sustainable solution is to set $p_2^{LE*} = \frac{(1+r)\alpha}{1-\alpha}G - \varepsilon$, where ε is infinitesimal. We consider the following possible solutions.

(i.a) The interior solution {$p_1^{LE*} = \frac{G}{2}(1+2r-\alpha)$, $p_2^{LE*} = rG$}

(i.b) The corner solution {$p_1^{LE*} = G(1+2r)\alpha - \varepsilon$, $p_2^{LE*} = rG$}, which is obtained by plugging $p_2^{LE*} = rG$ into $p_1^{LE*} < p_2^{LE*}\alpha + G(1+r)\alpha$.

(i.c) The corner solution {$p_1^{LE*} = p_2^{LE*} = \frac{(1+r)\alpha}{1-\alpha}G - \varepsilon$}, which is obtained by setting $p_2^{LE*} = p_1^{LE*} < p_2^{LE*}\alpha + G(1+r)\alpha$.

At equilibrium prices p_1^{LE*} and p_2^{LE*}, the equilibrium firm profit can be derived as

$$\Pi^{LE*} = 2\alpha((1 - \frac{p_1^{LE*} - p_2^{LE*}}{G(1-\alpha)})p_1^{LE*} + \frac{p_1^{LE*} - p_2^{LE*}}{G(1-\alpha)}p_2^{LE*}) + 2(1-\alpha)p_2^{LE*}. \quad (43)$$

The consumer surplus can be derived as

$$\begin{aligned}\Gamma^{LE}(p_1,p_2) &= 2\alpha(1-\frac{p_1-p_2}{G(1-\alpha)})(G-p_1)+ \\ &2\alpha\int_{1-\frac{p_1-p_2}{G(1-\alpha)}}^{1}(\alpha(G-p_2)+(1-\alpha)(\beta G-p_2))dF\beta+ \\ &2(1-\alpha)\int_0^1(\alpha(G-p_2)+(1-\alpha)(\beta G-p_2))dF\beta \\ &= 2\alpha(1-\frac{p_1-p_2}{G(1-\alpha)})(G-p_1)+2\alpha\frac{2G(p_1-p_2)-p_1+p_2}{2G(1-\alpha)}+ \\ &2(1-\alpha)(\frac{G(1+\alpha)}{2}-p_2) \qquad (44)\end{aligned}$$

And $\Gamma^{LE*}=\Gamma^{LE}(p_1^{LE*},p_2^{LE*})$.

(ii) $p_2>(1+r-\frac{r}{\alpha})G$

In this case, the firm's profit function is $\Pi^{LE}=2\alpha((1-\frac{p_1-p_2}{G(1-\alpha)})p_1+\frac{p_1-p_2}{G(1-\alpha)}p_2)+2(1-\alpha)\frac{G-p_2}{G(1-\alpha)}p_2$. Note that $(1+r-\frac{r}{\alpha})G<\frac{(1+r)\alpha}{1-\alpha}G$ can be satisfied only if {$0<\alpha<\frac{1}{2}\&\frac{\alpha(1-2\alpha)}{1-2\alpha+2\alpha^2}<r<1$} or {$\frac{1}{2}<\alpha<1$}; otherwise the strategy $p_2>(1+r-\frac{r}{\alpha})G$ will not render a sustainable strategy that satisfies $p_2^*\leq p_1^*<p_2^*\alpha+G(1+r)\alpha$. We consider the following possible solutions.

(ii.a) The interior solution {$p_1^{LE*}=G$, $p_2^{LE*}=\frac{1+\alpha}{2}G$}.

(ii.b) The corner solution {$p_1^{LE*}=\frac{1}{2}G\alpha(3+2r+\alpha)-\varepsilon$, $p_2^{LE*}=\frac{1}{2}G(1+\alpha)$}, which is obtained by plugging $p_2^{LE*}=\frac{1}{2}G(1+\alpha)$ into $p_1^{LE*}<p_2^{LE*}\alpha+G(1+r)\alpha$.

(ii.c) The corner solution {$p_1^{LE*}=G,p_2^{LE*}=(\frac{1}{\alpha}-1-r)G+\varepsilon$}, which is obtained by plugging $p_1^{LE*}=G$ into $p_1^{LE*}<p_2^{LE*}\alpha+G(1+r)\alpha$.

At equilibrium prices p_1^{LE*} and p_2^{LE*}, the equilibrium firm profit can be derived as $\Pi^{LE*}=\Pi^{LE}(p_1^{LE*},p_2^{LE*})$.

the consumer surplus can be derived as

$$\begin{aligned}\Gamma^{LE} &= 2\alpha(1-\frac{p_1-p_2}{G(1-\alpha)})(G-p_1)+ \\ &\quad 2\alpha\int_{1-\frac{p_1-p_2}{G(1-\alpha)}}^{1}(\alpha(G-p_2)+(1-\alpha)(\beta G-p_2))dF\beta+ \\ &\quad 2(1-\alpha)\int_{1-\frac{G-p_2}{G(1-\alpha)}}^{1}(\alpha(G-p_2)+(1-\alpha)(\beta G-p_2))dF\beta \\ &= 2\alpha(1-\frac{p_1-p_2}{G(1-\alpha)})(G-p_1^*)+2\alpha\frac{2G(p_1-p_2)-p_1+p_2}{2G(1-\alpha)}+ \\ &\quad 2(1-\alpha)\frac{(G-p_2)^2}{2G(1-\alpha)}\end{aligned}$$

and

$$\Gamma^{LE*} = \Gamma^{LE}(p_1^{LE*}, p_2^{LE*}) \tag{45}$$

(iii) $rG < p_2 \leq (1+r-\frac{r}{\alpha})G$

In this case, the firm's profit function is $\Pi^{LE} = 2\alpha((1-\frac{p_1-p_2}{G(1-\alpha)})p_1+\frac{p_1-p_2}{G(1-\alpha)}p_2)+2(1-\alpha)((1+r-\frac{p_2}{G})p_2+(\frac{p_2}{G}-r)\alpha p_2-hG(\frac{p_2}{G}-r)(1-\alpha))$. The interior solution can be solved as $\{p_1^{LE*} = \frac{(-2+h(1-\alpha)^2-r(1-\alpha)^2+3\alpha-3\alpha^2+\alpha^3)}{-2(1-\alpha)^2}G, p_2^{LE*} = \frac{(1-h(1-\alpha)^2+r(1-\alpha)^2)}{2(1-\alpha)^2}G\}$.

Note that $rG < \frac{(1+r)\alpha}{1-\alpha}G$ can be satisfied only if $\frac{r}{1+2r} < \alpha < 1$; otherwise, strategy $rG < p_2 \leq (1+r-\frac{r}{\alpha})G$ will not render a sustainable solution that satisfies $p_2^{LE*} \leq p_1^{LE*} < p_2^{LE*}\alpha + G(1+r)\alpha$. When $0 \leq \alpha \leq \frac{r}{1+2r}$, we consider the following possible solutions.

(iii.a) The interior solution, $\{p_1^{LE*} = \frac{(-2+h(1-\alpha)^2-r(1-\alpha)^2+3\alpha-3\alpha^2+\alpha^3)}{-2(1-\alpha)^2}G$ and $p_2^{LE*} = \frac{(1-h(1-\alpha)^2+r(1-\alpha)^2)}{2(-1+\alpha)^2}G\}$.

(iii.b) The corner solution $\{p_1^{LE*} = \frac{G(2r(-1+\alpha)+(3-\alpha)\alpha))}{2\alpha}, p_2^{LE*} = (1+r-\frac{r}{\alpha})G\}$, which is obtained by plugging $p_2^{LE*} = (1+r-\frac{r}{\alpha})G$ into $\partial\Pi^{LE}/\partial p_1 = 0$.

(iii.c) The corner solution $\{p_1^{LE*} = G(2\alpha+r(-1+2\alpha))-\varepsilon, p_2^* = (1+r-\frac{r}{\alpha})G\}$, which is obtained by plugging $p_2^{LE*} = (1+r-\frac{r}{\alpha})G$ into $p_1^{LE*} < p_2^{LE*}\alpha + G(1+r)\alpha$.

The equilibrium firm profit can be derived as $\Pi^{LE*} = \Pi^{LE}(p_1^{LE*}, p_2^{LE*})$.

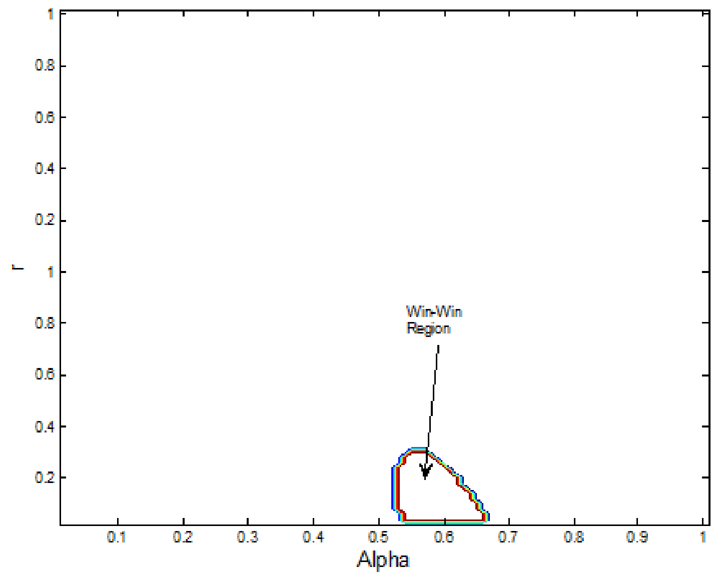

Figure A5: Win-Win Region Under Demand Overlap ($h = 0.1$).

The consumer surplus can be derived as

$$\begin{aligned}\Gamma^{LE} &= 2\alpha(1-\frac{p_1-p_2}{G(1-\alpha)})(G-p_1)+2\alpha\int_{1-\frac{p_1-p_2}{G(1-\alpha)}}^{1}(\alpha(G-p_2)+(1-\alpha)(\beta G-p_2))dF\beta + \qquad (46)\\ &\quad 2(1-\alpha)(\alpha(G-p_2)+(1-\alpha)\int_{\frac{p_2}{G}-r}^{1}((\beta G-p_2)dF\beta+(1-\alpha)\int_{0}^{\frac{p_2}{G}-r}(-rG)dF\beta))\\ &= 2\alpha(1-\frac{p_1-p_2}{G(1-\alpha)})(G-p_1^*)+2\alpha\frac{2G(p_1-p_2)-p_1+p_2}{2G(1-\alpha)}+\\ &\quad 2(1-\alpha)(\alpha(G-p_2)+(1-\alpha)(\frac{G^2-2Gp_2+p_2^2-r^2G^2}{2G})+(1-\alpha)\frac{p_2-rG}{G}(-rG))\end{aligned}$$

and

$$\Gamma^{LE*} = \Gamma^{LE}(p_1^{LE*}, p_2^{LE*}).$$

If $r > \alpha$

(iv) $p_2 \leq \alpha G$: this case is the same as case (i).

(v) $p_2 > \alpha G$: this case is the same as case (iii).

Stage 1: Firm Optimal Product Placement Strategy

Given the complex of the model, we resort to numerical solution. Figure (A5) illustrates the win-win region where $\Pi^{LE*} > \Pi^{LL*}$ and $\Gamma^{LE*} > \Gamma^{LL*}$ are simultaneously satisfied ($h = 0.1$).

Seller Incentive to Help Reduce Consumer Return Cost

In the main model, we treat the consumer return cost r as exogenously determined. We now consider the case when the firm can help reduce consumers' return cost at its own expenses. For example, the firm can pay for the return shipping fee, waive the restocking fee, and/or extend the return period to help reduce consumer return cost, which consequently increases the firm's operation cost. We let RG denote the firm's costly effort to reduce consumers' return cost from r to $r-R$, and restrict $0 \leq R \leq r$.[1] When a consumer keeps an online purchased product i, the retailer collects a revenue of p_i; when a consumer returns the product, the firm incurs an expense of $-RG$. We modify the game sequence in the main model as follows. In the first period stage, the firm decides the product placement for its two products. In the second stage, the firm decides the optimal retail prices for the two products, p_1^* and p_2^*, as well as the optimal effort/expense R^* to reduce consumer return cost. And in the third stage consumers make purchase decisions. Other specifications of the main model apply.

We solve the model backwardly. Note that the seller's effort to reduce consumer return cost does not affect demand conditions for either product in case LL, where both products are offered through the dual channel, or demand condition for product 1 in case LE, where product 1 is offered through the dual channel and product 2 is offered through the online channel exclusively. We thus focus on examining demand condition for product 2 in case LE. In stage 3, a type 2 consumer buys a product 2 at the online store if her *ex ante* expected utility EU_2^E is non-negative, with

$$EU_2^E = \begin{cases} \alpha(G-p_2)+(1-\alpha)(\beta G-p_2) & if \quad \beta \geq \frac{p_2}{G}-(r-R) \\ \alpha(G-p_2)+(1-\alpha)(-(r-R)G) & if \quad \beta < \frac{p_2}{G}-(r-R) \end{cases} \tag{47}$$

In stage 2, If $r-R \leq \alpha$, we derive the realized demand for product 2 and the seller's profit from selling product 2 as

$$D_2^{LE} = \begin{cases} 1 & if & p_2 \leq (r-R)G \\ (1-\frac{p_2}{G}+(r-R))+(\frac{p_2}{G}-(r-R))\alpha & if & (r-R)G < p_2 \leq (1+(r-R)-\frac{(r-R)}{\alpha})G \\ \frac{G-p_2}{G(1-\alpha)} & if & p_2 > (1+(r-R)-\frac{(r-R)}{\alpha})G \end{cases} \tag{48}$$

[1]Our introduction of R does not imply that there is no return cost to the customer. Non-monetary costs such as hassle costs, travel costs would still be incurred by the customer.

and

$$\pi_2^{LE} = \begin{cases} p_2 & if \quad p_2 \leq (r-R)G \\ (1-\frac{p_2}{G}+(r-R))p_2 \\ +(\frac{p_2}{G}-(r-R))(\alpha p_2-(1-\alpha)(h+R)G) & if \quad (r-R)G < p_2 \leq (1+(r-R)-\frac{(r-R)}{\alpha})G \\ \frac{G-p_2}{G(1-\alpha)}p_2 & if \quad p_2 > (1+(r-R)-\frac{(r-R)}{\alpha})G \end{cases} \tag{49}$$

If $r-R>\alpha$, the realized demand for product 2 and the seller's profit from selling product 2 can be derived as $D_2^{LE} = \begin{cases} 1 & if \quad p_2 \leq \alpha G \\ \frac{G-p_1}{G(1-\alpha)} & if \quad p_2 > \alpha G \end{cases}$ and

$$\pi_2^{LE} = \begin{cases} p_2 & if \quad p_2 \leq \alpha G \\ \frac{G-p_2}{G(1-\alpha)}p_2 & if \quad p_2 > \alpha G \end{cases} \tag{50}$$

We solve the seller's optimal strategy $\{R^*, p_2^*\}$ in following conditions.

(1) $r-R \leq \alpha$

(1.a) If $p_2 \leq (r-R)G$, the seller's profit function is $\pi_2^{LE} = p_2$; the seller 's optimal strategy can be solved as $\{R^*=0, p_2^*=rG\}$; the maximized seller profit is $\pi_2^*=rG$.

(1.b) if $(r-R)G < p_2 \leq (1+(r-R)-\frac{(r-R)}{\alpha})G$, the seller's profit function is $\pi_2^{LE} = (1-\frac{p_2}{G}+(r-R))p_2+(\frac{p_2}{G}-(r-R))(\alpha p_2-(1-\alpha)(h+R)G)$. We take the first order derivative of π_2^{LE} with respect to p_2 and R respectively, and obtain

$$\frac{\partial \pi}{\partial p_2} = \frac{(2p_2(-1+\alpha)+G(1+r-2R+h(-1+\alpha)-r\alpha+2R\alpha))}{G} \tag{51}$$

$$\frac{\partial \pi}{\partial R} = -(2p_2+G(h-r+2R))(1-\alpha) \tag{52}$$

It can be proved that at the interior solution of the optimal price $p_2^* = \frac{G(-1+h+2R+r(-1+\alpha)-h\alpha-2R\alpha)}{2(-1+\alpha)}$ that satisfies $\frac{\partial\pi}{\partial p}=0$, we obtain $\frac{\partial\pi}{\partial R}=-G<0$. We thus derive the optimal seller strategy as $\{R^*=0, p_2^*=\frac{G(1-h+r(1-\alpha)+h\alpha)}{2(1-\alpha)}\}$, and the maximized seller profit of

$\pi_2^{LE*} = \frac{G((1-r(1-\alpha))^2-2h(1-r(1-\alpha))(1-\alpha)+h^2(1-\alpha)^2)}{4(1-\alpha)}$. This strategy sustains as long as $0 \leq \alpha \leq \frac{1+h}{2+h}$&$0 \leq r \leq \underline{r} = \frac{\alpha-2\alpha^2+h\alpha(1-\alpha)}{2-3\alpha+\alpha^2}$. At the corner solution of the optimal price $p_2^* = (1+(r-R)-\frac{(r-R)}{\alpha})G$, $\frac{\partial\pi}{\partial R}=0$ leads to $R^*=\frac{(2r-2\alpha-h\alpha-r\alpha)}{2}$. The seller's optimal strategy is thus $\{R^*=\frac{2r-2\alpha-h\alpha-r\alpha}{2}, p_2^*=\frac{G(-h-r+2\alpha+h\alpha+r\alpha)}{2}\}$. Note that this strategy is not sustainable since R does not satisfy $R^* \geq r-\alpha$ and $R^* \geq 0$. Therefore, there are two sustainable solutions: If $r \leq \alpha$, $\{R^*=0, p_2^*=(1+r-\frac{r}{\alpha})G\}$, and the seller profit is $\pi_2^{LE} = \frac{-r^2(1-\alpha)^2+r(1-\alpha+h)(1-\alpha)\alpha+\alpha^2(\alpha-h(1-\alpha))}{\alpha^2}G$. If $r>\alpha$, $\{R^*=r-\alpha, p^*=\alpha G\}$, and the seller profit is $\pi_2^{LE*}=\alpha G$.

(1.3) If $p_2 > (1 + (r - R) - \frac{(r-R)}{\alpha})G$, the seller's profit function is $\pi_2^{LE} = \frac{G-p_2}{G(1-\alpha)}p_2$; the optimal seller strategy can be solved as $\{R^* = 0, p_2^* = \frac{G}{2}\}$, which leads to the seller profit of $\pi_2^{LE*} = \frac{1}{4(1-\alpha)}G$.

(2) $r - R > \alpha$. In this case, the seller's profit does not depend on R.

(2.a) If $p_2 \leq \alpha G$: the seller 's profit function is $\pi_2^{LE} = p_2$; the seller 's optimal strategy can be solved as $\{R^* = 0, p_2^* = \alpha G\}$, which leads to its maximized seller profit of $\pi_2^* = \alpha G$.

(2.b) If $p_2 > \alpha G$: the seller 's profit function is $\pi_2^{LE} = \frac{G-p_2}{G(1-\alpha)}p_2$; the seller 's optimal strategy is $\{R^* = 0, p_2^* = G/2\}$, which leads to its maximized profit of $\pi_2^{LE*} = \frac{1}{4(1-\alpha)}G$.

It can be proved that strategy (2.b) sustains only if $\alpha < \frac{1}{2}$ and in this parameter range strategy (2.b)always dominates strategy (2.a)

Summarizing our analysis, we obtain that the seller has incentive to reduce consumers' return cost at its own expense only if $r > \alpha > \frac{1}{2}$ (region D defined in Lemma 2), $\{R^* = r - \alpha$ and $p^* = \alpha G\}$, and the seller profit is $\pi_2^{LE*} = \alpha G$. In this case, all type 2 consumers buy and keep product 2 and the total consumer surplus is $\gamma_2 = \alpha(1-\alpha)G + (1-\alpha)\int_0^1(\beta G - \alpha G)dF\beta = \frac{1}{2}(1-\alpha)G$. The seller profit and the consumer surplus are the same as in the main model where the firm does not help reduce consumer return cost at its own expenses. In all other regions, the seller has no incentive to help reduce consumer return cost at its own expenses. Therefore, Propositions 1-2 and Corollary 1 in the main model continue to hold.

Cost to Visit the Local Store

In the main model, we assume zero cost to visit the local store or order from the online store to abstract out consumers' store visit decision. Our analysis reveals the interesting result that even when fit-uncertain consumers have access to the offline store, the multi-channel seller still benefits from selling a part of its product line through the online channel exclusively. Our key insight and core results continue to hold as long as fit-uncertain consumers have access to the seller's physical store to conduct pseudo-showrooming. When consumers have to incur a cost to visit the local store, they decide between (i) paying the store-visiting cost and partially resolving uncertainty regarding the online exclusive product prior to purchase, or (ii) not visiting the store and making online purchase decisions under full uncertainty about the online exclusive product. Consumers will take option (i) when their store visiting cost is sufficiently low. Once these consumers have arrived at the local store, their store-visiting cost becomes sunk and does not affect their subsequent product purchase decisions or product return decisions any more. As such, pseudo-showrooming affects these consumers' choice behaviors and the firm's strategic activities in the same way as in the main model. And our main model results regarding the benefits of offering online exclusive products and inducing consumer pseudo-showrooming continue to hold.

We extend the main model to consider two types of consumers in the market with low and high costs to visit the local store. We model a proportion $s(0 \leq s \leq 1)$ of consumers incur zero cost to visit the local store and thus always do so. These consumers' behaviors are the same as in the main model. The remaining proportion $1 - s$ of consumers incur a sufficiently high store visiting cost that practically impedes a store visit and always buy from the online store directly. These consumers' choice behaviors are the same as modeled in case EE (Section 4.1). We solve the model through numerical simulation. Consistent with the main model results, our analysis reveals a win-win region where the seller generates a greater profit as well as a greater consumer surplus when it sells one product exclusively online. For example, if $s = 0.5$, $G = 1$, $\alpha = 0.5$, and $r = 0.3$, the seller' maximized profit in case LL and case LE are 0.5169 and 0.5261, respectively; and the consumers' total surplus in case LL and case LE are 0.0198 and 0.0962, respectively.

We have also examined the case when some consumers already know product fit and their misfit tolerance. These consumers are indifferent between online and offline shopping if the cost of visiting the local store is zero and will order from the online store if the cost of visiting the local store is non-trivial. These consumers base their purchase decisions on the product's price, and will not return a product if a purchase is made. For these consumers whether a product is offered through the local store is not relevant. As such, the existence of these consumers in the market does not impair our key insight regarding fit-uncertain consumers who visit the local store. We model that a proportion k(0<k<1) of consumers are uncertain about the products' fit and their misfit tolerance level before inspecting the product, and the remaining proportion 1-k of consumers are fully informed about the product fit and their misfit tolerance level even before inspecting the product. We solve the model through numerical simulation. Consistent with the main model results, our analysis reveals a win-win region where the seller generates a greater profit and also a greater consumer surplus when it sells one product exclusively online. For example, if $k = 0.7$, $G = 1$, $\alpha = 0.4$, and $r = 0.25$, the seller' maximized profit in case LL and case LE are 0.4167 and 0.4394, respectively; and the consumers' total surplus in case LL and case LE are 0.0822 and 0.1894, respectively.

Pseudo-Showrooming Clears Product Fit Uncertainty But Not Uncertainty About Misfit Tolerance

The essential intuition behind our results is that consumers have two dimensions of uncertainties (uncertainty in product fit and uncertainty in misfit tolerance) and pseudo-showrooming by clearing one dimension of the consumer uncertainty but not the other can benefit the multi-channel seller. In our study, we assume that pseudo-showrooming clears a consumer's uncertainty in misfit tolerance but not in product fit because conceptually the perception of misfit tolerance is specific to the consumer and product fit is specific to the product. To demonstrate the robustness of key insights, we now examine a case where pseudo-showrooming clears a consumer's uncertainty in product fit but not in misfit tolerance.

Note that the firm strategy and maximized profit in case LL when the firm sells both products through the dual channel is the same as in the main model. Now we consider case LE when the firm sells product 1 through the dual channel and product 2 through the online channel only. Type 1 consumers' utility with product 1 and the firm's optimal pricing strategy regarding product 1 are the same as in the main model. For type 2 consumers, a proportion α find a good fit with product 2 and have the utility of

$$U_2(f=g) = G - p_2. \tag{53}$$

These consumers buy product 2 as long as $p_2 \leq G$. A proportion $1-\alpha$ of type 2 consumers find a bad fit with product 2 and have a utility of

$$U_2(f=b) = \begin{cases} \int_0^1 (\beta G - p_2) dF\beta = \frac{1}{2}(G - 2p_2) & if \quad p_2 \leq rG \\ \int_{\frac{p_2}{G}-r}^1 (\beta G - p_2) dF\beta + \int_0^{\frac{p_2}{G}-r} (-rG) dF\beta \\ = \frac{p^2 - 2Gp(1+r) + G^2(1+r^2)}{2G} & if \quad p_2 > rG \end{cases} \tag{54}$$

These consumers buy product 2 if $U(f=b) \geq 0$, which is satisfied if $p_2 \leq \min\{\frac{1}{2}G, rG\}$ or if $rG < p_2 \leq G(1+r-\sqrt{2r})$. Note that the latter condition $rG < p_2 \leq G(1+r-\sqrt{2r})$ can be satisfied only if $r < \frac{1}{2}$ and that in this condition when $p_2 > rG$ consumers with $\beta > 1 + r - \frac{p_2}{G}$ will return the product after finding their true misfit tolerance. We summarize consumer demand function below.

If $r < \frac{1}{2}$, the demand function can be summarized as

$$D_2 = \begin{cases} 1 & if & p_2 \leq rG \\ \alpha + (1-\alpha)(1 + r - \frac{p_2}{G}) & if & rG < p_2 \leq G(1+r-\sqrt{2r}) \\ \alpha & if & r < \frac{1}{2} \& G(1+r-\sqrt{2r}) < p_2 \leq G \end{cases} \tag{55}$$

The firm's profit function is thus

$$\pi_2^{LE} = \begin{cases} p_2 & if \quad p_2 \le rG \\ (\alpha + (1-\alpha)(1+r-\frac{p_2}{G}))p_2 - hG(\frac{p_2}{G}-r)(1-\alpha) & if \quad rG < p_2 \le G(1+r-\sqrt{2r}) \\ \alpha p_2 & if \quad G(1+r-\sqrt{2r}) < p_2 \le G \end{cases} \tag{56}$$

We solve the firm's optimal price that maximizes π_2^{LE} in the following cases.

(i) $p_2 \le rG$

In this case, the profit function is $\pi_2^{LE} = p_2$; the optimal price is $p_2^{LE*} = rG$, which renders a maximized firm profit of $\pi_2^{LE*} = rG$. The consumer surplus can be derived as $\gamma_2^{LE*} = \alpha(G - p_2^{LE*}) + (1-\alpha)\int_0^1(\beta G - p_2^{LE*})dF\beta = \frac{1}{2}(G - 2p_2^{LE*} + G\alpha) = \frac{G}{2}(1-2r+\alpha)$.

(ii) If $rG < p_2 \le G(1+r-\sqrt{2r})$

In this case, the profit function is $\pi_2^{LE} = (\alpha + (1-\alpha)(1+r-\frac{p_2}{G}))p_2 - hG(\frac{p_2}{G}-r)(1-\alpha)$. The interior solution can be solved as $p_2^{LE*} = \frac{1+(r-h)(1-\alpha)}{2(1-\alpha)}G$, which sustains if {$0 \le \alpha \le \frac{1+h}{2+h} \& 0 \le r \le \underline{r} = \frac{3-2\alpha-h(1-\alpha)}{1-\alpha} - 2\sqrt{\frac{2(1-h+h\alpha)}{1-\alpha}}$}.

(ii.a) If $0 \le \alpha \le \frac{1+h}{2+h} \& 0 \le r \le \underline{r}$

The interior solution constitutes the optimal price, $p_2^{LE*} = \frac{(1-h+r(1-\alpha)+h\alpha)}{2(1-\alpha)}G$, which renders a maximized firm profit of $\pi_2^{LE*} = \frac{((1+r(1-\alpha))^2+2h(1+r(-1+\alpha))(-1+\alpha)+h^2(1-\alpha)^2)}{4(1-\alpha)}G$.

The consumer surplus can be derived as

$$\begin{aligned} \gamma_2^{LE} &= \alpha(G-p_2) + (1-\alpha)\int_{\frac{p_2}{G}-r}^{1}(\beta G - p_2)dF\beta + (1-\alpha)\int_0^{\frac{p_2}{G}-r}(-rG)dF\beta \\ &= \alpha(G-p_2) + (1-\alpha)(\frac{G^2 - 2Gp_2 + p_2^2 - r^2G^2}{2G}) + (1-\alpha)\frac{p_2 - rG}{G}(-rG) \\ &= \frac{G(1+6r(-1+\alpha)+2h(1+r(1-\alpha))(1-\alpha)+h^2(1-\alpha)^2+r^2(1-\alpha)^2-4\alpha^2)}{8(1-\alpha)}; \\ &\text{and} \\ \gamma_2^{LE*} &= \gamma_2^{LE}(p_2^{LE*}) \end{aligned} \tag{57}$$

(ii.b) If $\alpha > \frac{1+h}{2+h}$ or $r > \underline{r}$

The corner solution $p_2^{LE*} = G(1+r-\sqrt{2r})$ constitutes the optimal price, which renders a maximized firm profit of

$$\pi_2^{LE*} = Gh(-1+\sqrt{2r})(1-\alpha) + G(1-\sqrt{2r}+r)(\sqrt{2r}(1-\alpha)+\alpha) \tag{58}$$

The consumer surplus can be derived as

$$\gamma_2^{LE*} = G(\sqrt{2r}-r)\alpha \tag{59}$$

(i.c) if $G(1+r-\sqrt{2r}) < p_2 \leq G$

In this case, the profit function is $\pi_2^{LE} = \alpha p_2$. The optimal price can be solved as $p_2^{LE*} = G$, which renders a maximized firm profit of $\pi_2^{LE*} = \alpha G$. The consumer surplus can be derived as $\gamma_2^{LE*} = \alpha(G - p_2) = 0$.

When $r > \frac{1}{2}$, the consumer demand function can be derived as

$$D_2 = \begin{cases} 1 & if \quad p_2 \leq \frac{1}{2}G \\ \alpha & if \quad p_2 > \frac{1}{2}G \end{cases} \tag{60}$$

And the firm's profit function is

$$\pi_2^{LE} = \begin{cases} p_2 & if \quad p_2 \leq \frac{1}{2}G \\ \alpha p_2 & if \quad p_2 > \frac{1}{2}G \end{cases} \tag{61}$$

We solve the firm's optimal price that maximizes π_2^{LE} in the following conditions.

(i) $p_2 \leq \frac{1}{2}G$

In this case, the firm's profit function is $\pi^{LE} = p_2$. The optimal price is $p_2^{LE*} = \frac{1}{2}G$, which renders a maximized firm profit of $\pi_2^{LE*} = \frac{1}{2}G$. The consumer surplus at p_2^{LE*} can be derived as

$$\gamma_2^{LE*} = \alpha(G - p_2) + (1-\alpha)\int_0^1 (\beta G - p_2) dF\beta = \frac{1}{2}(G - 2p_2 + G\alpha) = \frac{\alpha G}{2} \tag{62}$$

(ii) $\frac{1}{2}G < p_2 \leq G$

In this case, the firm's profit function is $\pi_2^{LE} = \alpha p_2$. The optimal price can be solved as $p_2^{LE*} = G$, which renders a maximized profit of $\pi_2^{LE*} = \alpha G$. The consumer surplus can be derived as $\gamma_2^{LE*} = \alpha(G - p_2) = 0$.

Strategy (i) dominates (ii) if and only if $\alpha < \frac{1}{2}$.

Our analysis confirms the existence of a win-win region where $\Pi^{LE*} > \Pi^{LL*}$ and $\Gamma^{LE*} > \Gamma^{LL*}$ are both satisfied when the fit probability of products is not too high or too low. Figure (A6) illustrates the win-win region when $h = 0.1$.

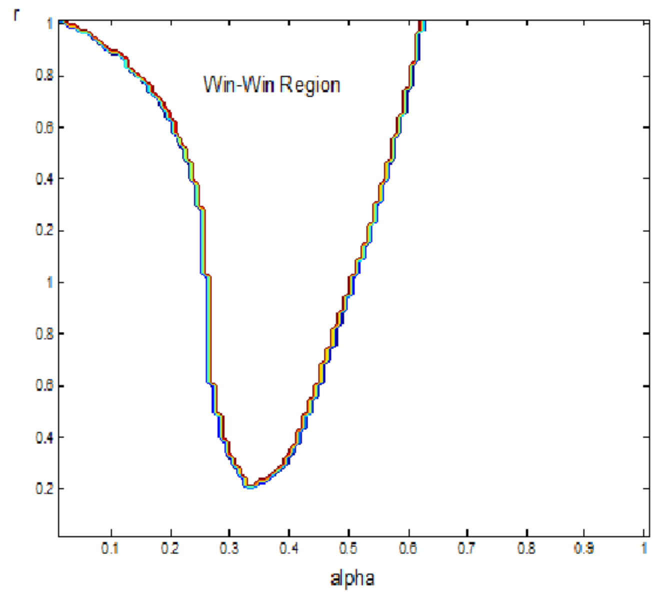

Figure A6: Win-Win Region When Pseudo-Showrooming Clears Consumer Uncertainty About Misfit Tolerance but Not About Product True Fit ($h = 0.1$).

Survey on Consumer Pseudo-Showrooming Behaviors

Dear respondents,

Thank you for taking the survey!

This survey is part of an academic project and aims to investigate consumers' shopping behaviors across online and offline channels. It takes about 5 minutes to complete.

Q1. Have you had the following shopping experiences?

You went shopping at a retailer's physical store (e.g., GAP). You inspected a product A (e.g., a Tshirt) that is displayed in the store, but didn't buy it. Instead, you went back home and bought product B (e.g., a sweater) from the same retailer's online store, although product B was not available at the retailer's physical store. Note that the physical store and the online store belong to the same retailer. The example is about apparel shopping, but you may have similar experiences with other products.

- o Yes
- o No

Q2. In the past 12 months, for how many times have you bought from online a product that is different from the one you inspected at the same retailer's physical store? Note that the physical store and the online store belong to the same retailer (e.g., Gap and Gap.com, Sears and Sears.com)

- o Never
- o 1-2 times
- o 3-5 times
- o 6 or more times

Q3. In which product categories have you bought from online a product that is different from the one you inspected at the same retailer's physical store? Note that the physical store and the online store belong to the same retailer (e.g., Gap and Gap.com, Sears and Sears.com)

- o Home appliances (e.g., refrigerator, washer, dryer)
- o Furniture and home improvement (e.g., bookshelf, dining sets, curtains, bedding)
- o Home tools (e.g., hand saw, driller)
- o Women's apparel, shoes, and accessories
- o Men's apparel, shoes, and accessories
- o Kids' apparel, shoes, and toys
- o Consumer electronics (digital camera, smart phone)
- o Sports gears (e.g., golf club, tennis racket, bikes)

Q4. In the past occasions that you bought from online a product that is different from the one you inspected at the same retailer's physical store, what are the differences between the two products? Note: please check all that apply.

- o The size if different (e.g., large vs. small)
- o The color is different (e.g., black vs. white)
- o The style is different (e.g, Vneck vs. boatneck)
- o Different products (e.g., jacket vs. pants)
- o The model is different (e.g., more vs. fewer features)
- o The quality is different (e.g., expensive vs. cheap materials)

Q5. In the past occasions that you bought from online a product that is different from the one you inspected at the same retailer's physical store, how do you feel the in-store inspection affect your online purchase? Please indicate your level of agreement with the following statements.

1: Strongly Disagree, 2: Disagree, 3: Somewhat Disagree, 4: Neither Agree nor Disagree, 5. Somewhat Agree, 6: Agree, 7: Strongly Agree.

Q5a. In-store inspection helped me understand the brand/product line better.

Q5b. In-store inspection provided me useful information about the product that I later bought online.

Q5c. In-store inspection helped me make better choice when I later shop online."

Q6. In the past occasions that you bought from online a product different from the one that you inspected at the same retailer's physical store, have you ever returned the online ordered product?

- o Yes
- o NO

Q7. Based on your past experience of returning online ordered product, please indicate your degree of agreement with the following statements.

1: Strongly Disagree, 2: Disagree, 3: Somewhat Disagree, 4: Neither Agree nor Disagree, 5. Somewhat Agree, 6: Agree, 7: Strongly Agree.

Q7a. I always return a product that I find didn't fit my needs

Q7b. I am never worried that my returns will not be accepted

Q7c. Making online returns is always a huge burden for me