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Reply to "Do Returns Policies Intensify Retail Competition?"

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Returns policies are common in many sectors of retail distribution. Padmanabhan and Png (1997) showed that with demand uncertainty, a returns policy could improve manufacturer profitability under certain conditions. Wang (2004) showed that returns policies do not change manufacturer profitability when demand is certain and retailing is competitive. We show that returns policies do increase manufacturer profitability by attenuating retailer price competition when demand is low and intensifying competition when demand is high. Importantly, this effect holds only in the presence of demand uncertainty. Further, the conditions under which a returns policy raises the manufacturer's profit are weaker when retailing is a duopoly than when retailing is a monopoly. This suggests that returns policies serve both to manage competition and mitigate demand uncertainty.

Key words: returns policies; retail competition; demand uncertainty; pricing
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1. Introduction

Marketing, operations management, and economics researchers have been interested in the conditions under which returns policies coordinate channels and supply chains (Pasternack 1985, Marvel and Peck 1995, Padmanabhan and Png 1995, Butz 1997, Cachon and Lariviere 2002, Granot and Yin 2002, Rao and Mahi 2003).[1]

Padmanabhan and Png (1997) showed that with demand uncertainty, a returns policy could improve manufacturer profitability under certain conditions. They further claimed that, even in the absence of demand uncertainty, a returns policy could raise manufacturer profitability by dampening price competition between retailers. However, this claim was disproved by Wang (2004), who showed that returns policies do not change manufacturer profitability when demand is certain and retailing is competitive.

In this paper, we show that returns policies do increase manufacturer profitability by helping it better manage price competition between retailers but that this effect holds only in the presence of demand uncertainty. Interestingly, the conditions under which a returns policy raises the manufacturer's profit are weaker when retailing is a duopoly than when retailing is a monopoly. This suggests that returns policies serve *both* to manage competition and mitigate demand uncertainty.[2]

2. Model

Let the information structure and sequence of actions be as follows. Initially, all parties are uncertain about the state of primary demand, which could be low or high ($\theta = l$ or h, respectively). The probability of demand being low is λ. In the first stage, the manufacturer sets a distribution policy comprising a wholesale price w and whether to accept returns. In the second stage, the retailers independently order stocks s_i. Then, in the third stage, the true primary demand state is revealed to *all parties*, and the retailers independently set prices, $p_{i\theta}$, $i = 1, 2$, $\theta = l, h$.[3] Let demand at retailer 1 be

$$q_{1\theta} = \alpha_\theta - \beta p_{1\theta} + \gamma p_{2\theta}. \qquad (1)$$

[1] Returns policies are one type of vertical control, another being resale price maintenance (Rey and Tirole 1986, Deneckere et al. 1997).

[2] Butz (1997) considered a similar setting but did not characterize the conditions under which a returns policy would increase manufacturer profit. However, he did allow *partial* returns policies and showed that these maximize the manufacturer's profit.

[3] Another approach would be to assume that retailers set prices *before* the state of demand is revealed (Marvel and Peck 1995, Dana and Spier 2001, Marvel and Wang 2003).

Demand is more sensitive to the retailer's own price than the competitor's price (i.e., $\beta > \gamma$). Information is symmetric: specifically, λ, α_θ, β, and γ are known to all.

2.1. No Returns

In this case, the manufacturer sets a wholesale price w and does not accept returns. Below, we derive a condition sufficient that, in Stage 3, if demand is low, both retailers price to leave some stock unsold. If demand is high, both retailers price to sell their entire stock (Wang 2004).

By (1), if demand is low, retailer 1's sales are

$$q_{1l} = \alpha_l - \beta p_{1l} + \gamma p_{2l}. \tag{2}$$

Since the retailers leave some stock unsold and unsold stock has no salvage value, retailer 1 would set price to maximize revenue

$$R_{1l} = p_{1l}[\alpha_l - \beta p_{1l} + \gamma p_{2l}]. \tag{3}$$

The first-order condition is $\alpha_l - 2\beta p_{1l} + \gamma p_{2l} = 0$. Similarly, retailer 2 would set price to maximize revenue, and its first-order condition would be $\alpha_l - 2\beta p_{2l} + \gamma p_{1l} = 0$. Solving simultaneously, we have the retailers' price if demand is low,

$$p_{1l} = \frac{2\beta+\gamma}{4\beta^2-\gamma^2}\alpha_l = \frac{\alpha_l}{2\beta-\gamma} = p_{2l}. \tag{4}$$

Substituting (4) in (2), q_{1l} is as shown in Table 1. Since $\beta > \gamma$, it follows that $p_{1l} > 0$ and $q_{1l} > 0$.

If demand is high, both retailers sell their entire stock; hence, their sales are

$$q_{1h} = \alpha_h - \beta p_{1h} + \gamma p_{2h} = s_1, \tag{5}$$

$$q_{2h} = \alpha_h - \beta p_{2h} + \gamma p_{1h} = s_2. \tag{6}$$

Solving for the prices, we have

$$p_{1h} = \frac{[\beta+\gamma]\alpha_h - \beta s_1 - \gamma s_2}{\beta^2-\gamma^2}, \tag{7}$$

$$p_{2h} = \frac{[\beta+\gamma]\alpha_h - \beta s_2 - \gamma s_1}{\beta^2-\gamma^2}. \tag{8}$$

In Stage 2, the retailers choose stocks s_i to maximize expected profit, given the wholesale price w set by the manufacturer. Retailer 1's expected profit is

$$\lambda p_{1l} q_{1l} + [1-\lambda] p_{1h} s_1 - w s_1. \tag{9}$$

The first-order condition with respect to s_1 yields

$$2\beta[1-\lambda]s_1 = [1-\lambda][\beta+\gamma]\alpha_h - [1-\lambda]\gamma s_2 - [\beta^2-\gamma^2]w, \tag{10}$$

and, likewise for retailer 2. In equilibrium, $s_1 = s_2$, hence

$$s_1 = \frac{\beta+\gamma}{[1-\lambda][2\beta+\gamma]}\{[1-\lambda]\alpha_h - [\beta-\gamma]w\} = s_2. \tag{11}$$

In Stage 1, the manufacturer sets w to maximize profit

$$\Pi_N = 2[w-c]s_1. \tag{12}$$

Substituting (11) in (12), the first-order condition with respect to w is

$$w = \frac{[1-\lambda]\alpha_h + [\beta-\gamma]c}{2[\beta-\gamma]}. \tag{13}$$

Substituting for w, retailer 1's price when demand is high, p_{1h}, and stocking quantity, s_1, are as shown in Table 1.

In equilibrium, we require that, if demand is low, both retailers leave some stock unsold, $q_{1l} < s_1$.

Table 1 Full Returns Vis-à-Vis No Returns

	No returns		Full returns
w	$\frac{[1-\lambda]\alpha_h + [\beta-\gamma]c}{2[\beta-\gamma]}$	$<$ (if $c=0$)	$\frac{\lambda\beta[2\beta+\gamma]\alpha_l + [1-\lambda][\beta+\gamma][2\beta-\gamma]\alpha_h + [\beta-\gamma][\beta+\gamma][2\beta-\gamma]c}{2[\beta-\gamma]\{\lambda\beta[2\beta+\gamma] + [1-\lambda][\beta+\gamma][2\beta-\gamma]\}}$
$s_1 = q_{1h}$	$\frac{[\beta+\gamma]\{[1-\lambda]\alpha_h - [\beta-\gamma]c\}}{2[1-\lambda][2\beta+\gamma]}$	$<$	$\frac{\beta+\gamma}{2[2\beta+\gamma]}\left\{\alpha_h + \frac{\lambda\beta[2\beta+\gamma][\alpha_h-\alpha_l] - [\beta-\gamma][\beta+\gamma][2\beta-\gamma]c}{2[\beta-\gamma]\{\lambda\beta[2\beta+\gamma] + [1-\lambda][\beta+\gamma][2\beta-\gamma]\}}\right\}$
p_{1l}	$\frac{\alpha_l}{2\beta-\gamma}$	$<$	$\frac{\alpha_l}{2\beta-\gamma} + \frac{\beta}{2\beta-\gamma}\left\{\frac{\lambda\beta[2\beta+\gamma]\alpha_l + [1-\lambda][\beta+\gamma][2\beta-\gamma]\alpha_h + [\beta-\gamma][\beta+\gamma][2\beta-\gamma]c}{2[\beta-\gamma]\{\lambda\beta[2\beta+\gamma] + [1-\lambda][\beta+\gamma][2\beta-\gamma]\}}\right\}$
q_{1l}	$\frac{\beta\alpha_l}{2\beta-\gamma}$	$>$	$\frac{\beta\alpha_l}{2\beta-\gamma} - \frac{\beta}{2\beta-\gamma}\left\{\frac{\lambda\beta[2\beta+\gamma]\alpha_l + [1-\lambda][\beta+\gamma][2\beta-\gamma]\alpha_h + [\beta-\gamma][\beta+\gamma][2\beta-\gamma]c}{2\{\lambda\beta[2\beta+\gamma] + [1-\lambda][\beta+\gamma][2\beta-\gamma]\}}\right\}$
p_{1h}	$\frac{[1-\lambda][3\beta+\gamma]\alpha_h + [\beta-\gamma][\beta+\gamma]c}{2[1-\lambda][\beta-\gamma][2\beta+\gamma]}$	$>$	$\frac{3\beta+\gamma}{2[2\beta+\gamma]}\alpha_h - \frac{\beta+\gamma}{2[\beta-\gamma][2\beta+\gamma]}\left\{\frac{\lambda\beta[2\beta+\gamma][\alpha_h-\alpha_l] - [\beta-\gamma][\beta+\gamma][2\beta-\gamma]c}{\lambda\beta[2\beta+\gamma] + [1-\lambda][\beta+\gamma][2\beta-\gamma]}\right\}$

Substituting for these quantities from Table 1, a sufficient condition is

$$[\beta+\gamma][2\beta-\gamma][\alpha_h-2\alpha_l]-2\gamma^2\alpha_l > \frac{[\beta-\gamma][\beta+\gamma][2\beta-\gamma]}{1-\lambda}c. \quad (14)$$

Since $q_{1l}>0$, condition (14) also ensures that $s_1>0$.

2.2. Full Returns

In this case, the manufacturer sets a wholesale price w and gives each retailer a full refund for unsold stock. In the appendix (Claim 1), we show that condition (14) implies that, in Stage 3, if demand is low, both retailers price to leave some stock unsold. If demand is high, both retailers sell their entire stock (Wang 2004).

By (1), if demand is low, retailer 1's sales are

$$q_{1l}=\alpha_l-\beta p_{1l}+\gamma p_{2l}. \quad (15)$$

Since the retailers leave stock unsold and the manufacturer accepts full returns, retailer 1 would set price to maximize profit

$$[p_{1l}-w]q_{1l}=[p_{1l}-w][\alpha_l-\beta p_{1l}+\gamma p_{2l}]. \quad (16)$$

The first-order condition is $\alpha_l-2\beta p_{1l}+\gamma p_{2l}+\beta w=0$ and, similarly, for retailer 2, $\alpha_l-2\beta p_{2l}+\gamma p_{1l}+\beta w=0$. Solving, we have the retailers' price if demand is low,

$$p_{1l}=\frac{\alpha_l+\beta w}{2\beta-\gamma}=p_{2l}. \quad (17)$$

Substituting in (15), the retailers' sales are

$$q_{1l}=\alpha_l-[\beta-\gamma]\frac{\alpha_l+\beta w}{2\beta-\gamma}=\frac{\beta\alpha_l-\beta[\beta-\gamma]w}{2\beta-\gamma} \quad (18)$$

If demand is high, both retailers price to sell their entire stock. Then the sales and prices of retailers 1 and 2 are given by (5)–(8).

In Stage 2, the retailers choose stocks s_i to maximize expected profit, given the wholesale price w set by the manufacturer. Retailer 1's expected profit is

$$\lambda[p_{1l}-w]q_{1l}+[1-\lambda][p_{1h}-w]s_1. \quad (19)$$

Substituting from (17) and (7) in (19), the first-order condition with respect to s_1 is

$$2\beta s_1=[\beta+\gamma]\alpha_h-[\beta^2-\gamma^2]w-\gamma s_2, \quad (20)$$

and likewise for s_2. In equilibrium, $s_1=s_2$, hence

$$s_1=\frac{\beta+\gamma}{2\beta+\gamma}\{\alpha_h-[\beta-\gamma]w\}=s_2. \quad (21)$$

In Stage 1, the manufacturer sets w to maximize profit

$$\Pi_R=2\lambda w q_{1l}+2[1-\lambda]ws_1-2cs_1 \quad (22)$$

Substituting (21) in (22), the first-order condition with respect to w is

$$w=(\lambda\beta[2\beta+\gamma]\alpha_l+[1-\lambda][\beta+\gamma][2\beta-\gamma]\alpha_h+[\beta-\gamma][\beta+\gamma][2\beta-\gamma]c)/(2[\beta-\gamma]\{\lambda\beta[2\beta+\gamma]+[1-\lambda][\beta+\gamma][2\beta-\gamma]\}). \quad (23)$$

Substituting for w in (18) and simplifying, the stock is

$$s_1=\frac{\beta+\gamma}{2[2\beta+\gamma]}\cdot\Big\{\alpha_h+\big(\lambda\beta[2\beta+\gamma][\alpha_h-\alpha_l]-[\beta-\gamma][\beta+\gamma][2\beta-\gamma]c\big)\Big/\big(2[\beta-\gamma]\{\lambda\beta[2\beta+\gamma]+[1-\lambda][\beta+\gamma][2\beta-\gamma]\}\big)\Big\}. \quad (24)$$

The expressions for p_{1l}, q_{1l}, and p_{1h} are as reported in Table 1. From Table 1, a sufficient condition for $q_{1l}>0$ is $\alpha_l>w$, or by (23) and simplifying,

$$\lambda\beta[\beta+\gamma]\alpha_l-[\beta-\gamma][\beta+\gamma][2\beta-\gamma]c > [1-\lambda][\beta+\gamma][2\beta-\gamma][\alpha_h-2\alpha_l]. \quad (25)$$

3. Full Returns Vis-à-Vis No Returns

The Table 1 compares the profit-maximizing wholesale price, and equilibrium retail prices and quantities under the scenarios of full and no returns.[4, 5]

In general, it is difficult to compare the manufacturer's profit under the two scenarios. For tractability, we focus on the case where the marginal cost of the product, $c=0$. Then, by (12), (13), and (11), the manufacturer profit with no returns simplifies to

$$\Pi_N=\frac{[1-\lambda][\beta+\gamma]\alpha_h^2}{2[\beta-\gamma][2\beta+\gamma]}. \quad (26)$$

Further, by substituting $c=0$ in (22), (23), and (24) and simplifying, the manufacturer's profit with returns is

$$\Pi_R=\big(\{\lambda\beta[2\beta+\gamma]\alpha_l+[1-\lambda][\beta+\gamma][2\beta-\gamma]\alpha_h\}^2\big)\big/\big(2[\beta-\gamma][2\beta-\gamma][2\beta+\gamma]\{\lambda\beta[2\beta+\gamma]+[1-\lambda][\beta+\gamma][2\beta-\gamma]\}\big) \quad (27)$$

[4] In the case of $\gamma=0$, these variables simplify to the corresponding terms in Padmanabhan and Png (1997, Table 3).

[5] Most of the results in Table 1 are simple algebra. Equation (7) characterizes p_{1h} without and with returns. Since the stock is higher with returns, (7) implies that the price would be lower.

Comparing (27) with (26), the difference in the manufacturer's profit with and without returns, $\Pi_R - \Pi_N > 0$ if

$$[1-\lambda]\{\lambda\beta[2\beta+\gamma]\alpha_l + [1-\lambda][\beta+\gamma][2\beta-\gamma]\alpha_h\}^2 > [\beta+\gamma][2\beta-\gamma]\{[1-\lambda]\alpha_h]\}^2 \cdot \{\lambda\beta[2\beta+\gamma]+[1-\lambda][\beta+\gamma][2\beta-\gamma]\}. \quad (28)$$

After simplifying, we have the following result.

Proposition 1. *If the extent to which the high demand exceeds the low demand satisfies*

$$\frac{\alpha_h[\alpha_h-2\alpha_l]}{\alpha_l^2} < \frac{\lambda\beta[2\beta+\gamma]}{[1-\lambda][\beta+\gamma][2\beta-\gamma]}, \quad (29)$$

and the marginal cost of the product, c, is sufficiently low, then the manufacturer's profit is higher with a returns policy than with no returns.

Intuitively, the returns policy has conflicting effects on the manufacturer's profit:

• With returns, the retailers order larger stocks and, if the marginal cost is sufficiently low, the wholesale price is higher.

• However, with returns, in the event of low demand, retailers return unsold stock and the manufacturer must bear the cost of these returned items.

The appendix (Claim 2) shows that if $c = 0$ and, in addition,

$$\frac{\lambda}{1-\lambda} > \frac{4\gamma^2}{[\beta+\gamma][2\beta-\gamma]}, \quad (30)$$

then (14) implies (25) and (29). Accordingly, the conditions under which a returns policy increases the manufacturer's profit are well defined.

4. Comparing Retail Market Structures

In a similar setting of demand uncertainty but with a monopoly retailer, Padmanabhan and Png (1997) showed that the manufacturer's profit would be higher with a returns policy than with no returns if $c = 0$, and the demand parameters satisfied the condition,

$$\chi \le \frac{\lambda}{[1-\lambda]^{1/2}-[1-\lambda]}, \quad (31)$$

where $\chi \equiv \alpha_h/\alpha_l$. Using the same substitution, (29) becomes

$$[\chi-1]^2 \le \frac{\lambda\beta[2\beta+\gamma]}{[1-\lambda][\beta+\gamma][2\beta-\gamma]}+1, \quad (32)$$

or

$$\chi \le \left[\frac{\beta[2\beta+\gamma]+[1-\lambda][2\beta^2+\beta\gamma-\gamma^2]}{[1-\lambda][\beta+\gamma][2\beta-\gamma]}\right]^{1/2} + 1 \equiv X(\lambda), \quad (33)$$

say. Note that, with $\gamma = 0$,

$$X(\lambda) = \left[\frac{1}{1-\lambda}\right]^{1/2} + 1 = \frac{\lambda}{[1-\lambda]^{1/2}-[1-\lambda]}. \quad (34)$$

By (33), $X(\lambda)$ is increasing in γ, and thus, for $\gamma \ge 0$,

$$X(\lambda) \equiv \left[\frac{2\beta-\gamma+\lambda\gamma}{[1-\lambda]2\beta-\gamma+\lambda\gamma}\right]^{1/2} + 1 > \frac{\lambda}{[1-\lambda]^{1/2}-[1-\lambda]}. \quad (35)$$

Accordingly, (29) is weaker than (31), which leads to the following result.

Proposition 2. *The returns policy is more likely to raise the manufacturer's profit when retailing is a duopoly than when retailing is a monopoly.*

5. Concluding Remarks

We have shown that, in a setting of a retail duopoly subject to demand uncertainty, a returns policy will raise the manufacturer's profit if the marginal cost of the product is sufficiently low and the demand parameters satisfy particular conditions. Further, these conditions are weaker than the corresponding conditions for a returns policy to raise manufacturer profit with a retail monopoly. Hence, the returns policy is more likely to raise manufacturer profit when retailing is a duopoly than when retailing is a monopoly. The returns policy serves to manage competition *and* mitigate demand uncertainty.

Intuitively, when demand is low, the returns policy sets a floor to the retail price and dampens competition. However, when demand is high, the returns policy induces more intense price competition and, consequently, higher retail sales. By eliminating the cost of excess inventory and through its impact on retail competition, the returns policy encourages retailers to order larger stocks. Further, if the marginal cost is sufficient low, the returns policy leads to a higher wholesale price. From the manufacturer's viewpoint, the disadvantage of the returns policy is the cost of items returned in the event that demand is low. Provided that the cost of the product is sufficiently low and the high demand is not too much larger than the low demand, the advantages of the returns policy outweigh the disadvantage.

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Appendix

Claim 1. In the case of returns, condition (14) implies that $s_1 > q_{1l}$.

Proof. From Table 1, $s_1 > q_{1l}$ if

$$\frac{\beta+\gamma}{2\beta+\gamma}\{\alpha_h - [\beta-\gamma]w\} > \frac{\beta\alpha_l - \beta[\beta-\gamma]w}{2\beta-\gamma}, \tag{A.1}$$

or

$$[\beta+\gamma][2\beta+\gamma]\alpha_h - \beta[\beta+\gamma]\alpha_l > -[\beta-\gamma]\gamma^2 w \tag{A.2}$$

Since $w > 0$, a sufficient condition is that

$$[\beta+\gamma][2\beta-\gamma]\alpha_h - \beta[\beta+\gamma]\alpha_l > 0, \tag{A.3}$$

which is implied by (14). □

Claim 2. If $c = 0$ and

$$\frac{\lambda}{1-\lambda} > \frac{4\gamma^2}{[\beta+\gamma][2\beta-\gamma]}, \tag{30}$$

then (14) implies (25) and (29).

Proof. Suppose that $c = 0$. Then (14) simplifies to

$$[\beta+\gamma][2\beta-\gamma][\alpha_h - 2\alpha_l] - 2\gamma^2\alpha_l > 0. \tag{A.4}$$

Further, (25) simplifies to

$$\lambda\beta[\beta+\gamma]\alpha_l > [1-\lambda][\beta+\gamma][2\beta-\gamma][\alpha_h - 2\alpha_l]. \tag{A.5}$$

Condition (A.4) is consistent with (A.5) if $\lambda\beta[\beta+\gamma]\alpha_l > 2[1-\lambda]\gamma^2\alpha_l$, or

$$\frac{\lambda}{1-\lambda} > \frac{\gamma^2}{\beta[\beta+\gamma]}, \tag{A.6}$$

which is implied by (30).

Using $\chi = \alpha_h/\alpha_l$, condition (A.4) may be rewritten as

$$\chi > \frac{2\beta[2\beta+\gamma]}{[\beta+\gamma][2\beta-\gamma]}. \tag{A.7}$$

Now if $c = 0$, by (29) and (32), $\Pi_R > \Pi_N$ if

$$[\chi-1]^2 < \frac{\lambda\beta[2\beta+\gamma]}{[1-\lambda][\beta+\gamma][2\beta-\gamma]} + 1. \tag{A.8}$$

Hence, (A.7) is consistent with (A.8) if

$$\frac{\lambda\beta[2\beta+\gamma]}{[1-\lambda][\beta+\gamma][2\beta-\gamma]} + 1 > \left[\frac{2\beta[2\beta+\gamma]}{[\beta+\gamma][2\beta-\gamma]} - 1\right]^2, \tag{A.9}$$

which simplifies to

$$\frac{4-3\lambda}{1-\lambda} \le \frac{4\beta[2\beta+\gamma]}{[\beta+\gamma][2\beta-\gamma]}, \tag{A.10}$$

which in turn simplifies to (30). □

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