Returns Policies and Retail Price Competition

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Introduction

Marketing, operations management, and economics researchers have been interested in the conditions under which returns policies may coordinate channels and supply chains (Pasternack 1985; Marvel and Peck 1995; Padmanabhan and Png 1995; Kandel 1996; Tsay 2001; Cachon and Lariviere 2002; Granot and Yin 2002).

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 end-user demand uncertainty, a returns policy could raise manufacturer profitability by dampening price competition between retailers. However, this claim was disproved by Wang (2003), 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 attenuating price competition between retailers, but, that this effect holds only in the presence of end-user 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 dampen competition and resolve demand uncertainty.

Setting

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. We assume that the true state of the primary demand is revealed to *all parties* after the second stage. Then, in the third stage, the retailers independently set prices, $p_{i\theta}$, $i = 1,2$, $\theta = l, h$.[1]

Let demand at retailer 1 be

$$q_{1\theta} = \alpha_\theta - \beta p_{1\theta} + \gamma p_{2\theta}, \tag{1}$$

where the demand is more sensitive to the retailer's own price than the competitor's price in the sense that

$$\beta > \gamma, \tag{2}$$

and likewise for retailer 2. Information is symmetric: specifically, λ, α_θ, β, and γ are known to all.

No Returns

In this case, the manufacturer sets a wholesale price w and does not accept unsold stock. Assume that, in stage 3, if demand is high, both retailers price to sell their entire stock, while if demand is low, both leave some stock unsold. Below, we derive a condition sufficient for this to be true.

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

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

By assumption, the retailers set price such that some stock will be unsold. Since unsold stock has no salvage value, retailer 1 would set price to maximize revenue

$$R_{1l} = p_{1l}[\alpha_l - \beta p_{1l} + \gamma p_{2l}]. \tag{4}$$

The first-order condition is

$$\alpha_l - 2\beta p_{1l} + \gamma p_{2l} = 0. \tag{5}$$

Similarly, retailer 2 would set price to maximize revenue, and its first-order condition would be

$$\alpha_l - 2\beta p_{2l} + \gamma p_{1l} = 0. \tag{6}$$

Solving (5) and (6), we have retailer 1's price if demand is low,

$$\left[\frac{4\beta^2 - \gamma^2}{2\beta}\right] p_{1l} = \left[1 + \frac{\gamma}{2\beta}\right]\alpha_l,$$

or

$$p_{1l} = \frac{2\beta + \gamma}{4\beta^2 - \gamma^2}\alpha_l = \frac{\alpha_l}{2\beta - \gamma}, \tag{7}$$

[1] 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).

which, is also retailer 2's price in the case of low demand. Substituting (7) in (3),

$$q_{1l} = \alpha_l - [\beta - \gamma]\frac{\alpha_l}{2\beta - \gamma} = \frac{\beta\alpha_l}{2\beta - \gamma}. \tag{8}$$

By assumption, if demand is high, both retailers price to sell their entire stock. Then the sales of retailers 1 and 2 are

$$q_{1h} = \alpha_h - \beta p_{1h} + \gamma p_{2h} = s_1, \tag{9}$$

$$q_{2h} = \alpha_h - \beta p_{2h} + \gamma p_{1h} = s_2. \tag{10}$$

Solving,

$$\alpha_h - \beta p_{1h} + \frac{\gamma}{\beta}[\alpha_h + \gamma p_{1h} - s_2] = s_1. \tag{11}$$

In equilibrium, $s_1 = s_2$, hence

$$p_{1h} = \frac{\alpha_h - s_1}{\beta - \gamma}, \tag{12}$$

and, likewise, for p_{2h}.

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

$$\lambda p_{1l} q_{1l} + [1 - \lambda] p_{1h} s_1 - w s_1. \tag{13}$$

The first-order condition with respect to s_1 is

$$\frac{1 - \lambda}{\beta - \gamma}[\alpha_h - 2s_1] = w,$$

or

$$s_1 = \frac{1}{2}[\alpha_h - \frac{\beta - \gamma}{1 - \lambda} w]. \tag{14}$$

In stage 1, the manufacturer sets w to maximize profit

$$\Pi_N = 2[w - c]s_1 = [w - c][\alpha_h - \frac{\beta - \gamma}{1 - \lambda} w]. \tag{15}$$

The first-order condition with respect to w is

$$\alpha_h - \frac{\beta - \gamma}{1 - \lambda}[2w - c] = 0,$$

hence,

$$w = \frac{1}{2}\left[\frac{[1 - \lambda]\alpha_h}{\beta - \gamma} + c\right]. \tag{16}$$

Substituting for w in (14), we have

$$s_1 = \frac{1}{4}[\alpha_h - \frac{\beta - \gamma}{1-\lambda}c]. \tag{17}$$

In equilibrium, we require that, if demand is low, both retailers leave some stock unsold, $q_{1l} \leq s_1$. By (8) and (17), this implies that

$$\frac{1}{4}\left[\alpha_h - \frac{\beta - \gamma}{1-\lambda}c\right] \geq \frac{\beta\alpha_l}{2\beta - \gamma},$$

i.e., the high demand should exceed the low demand by at least the following extent,

$$[2\beta - \gamma]\alpha_h - 4\beta\alpha_l \geq \frac{[\beta - \gamma][2\beta - \gamma]}{1-\lambda}c. \tag{18}$$

Substituting for w in (15), the manufacturer's profit is

$$\Pi_N = \frac{1}{4}\left[\frac{[1-\lambda]\alpha_h}{\beta - \gamma} - c\right]\left[\alpha_h - \frac{\beta - \gamma}{1-\lambda}c\right]. \tag{19}$$

Substituting from (17) in (11), retailer 1's price when demand is high,

$$p_{1h} = \frac{1}{4[\beta - \gamma]}\left[3\alpha_h + \frac{\beta - \gamma}{1-\lambda}c\right]. \tag{20}$$

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, we show that, condition (18) implies that, in stage 3, if demand is high, both retailers price to sell their entire stock, while if demand is low, both leave some stock unsold.

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

$$q_{1l} = \alpha_l - \beta p_{1l} + \gamma p_{2l}. \tag{21}$$

By assumption, the retailers set price such that some stock will be unsold. Since the manufacturer accepts full returns of unsold stock, retailer 1 would set price to maximize profit

$$[p_{1l} - w]q_{1l} = [p_{1l} - w][\alpha_l - \beta p_{1l} + \gamma p_{2l}]. \tag{22}$$

The first-order condition is

$$\alpha_l - 2\beta p_{1l} + \gamma p_{2l} + \beta w = 0, \tag{23}$$

and, similarly, for retailer

$$\alpha_l - 2\beta p_{2l} + \gamma p_{1l} + \beta w = 0\,. \tag{24}$$

Solving (23) and (24), we have retailer 1's price if demand is low,

$$p_{1l} = \frac{\alpha_l + \beta w}{2\beta - \gamma}\,, \tag{25}$$

and likewise for retailer 2. Substituting $p_{1l} = p_{2l}$ in (21), retailer 1's sales are

$$q_{1l} = \frac{\beta}{2\beta - \gamma}[\alpha_l - [\beta - \gamma]w]\,, \tag{26}$$

and likewise for retailer 2.

By assumption, 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 (9)-(14).

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

$$\begin{aligned} &\lambda[p_{1l} - w]q_{1l} + [1-\lambda][p_{1h} - w]s_1 \\ &\quad = \lambda[p_{1l} - w]q_{1l} + [1-\lambda]\left[\frac{\alpha_h - s_1}{\beta - \gamma} - w\right]s_1, \end{aligned} \tag{27}$$

after substituting from (12). The first-order condition with respect to s_1 is

$$s_1 = \frac{1}{2}[\alpha_h - [\beta - \gamma]w]\,. \tag{28}$$

In stage 1, the manufacturer sets w to maximize profit

$$\begin{aligned} &\Pi_R = 2\lambda w q_{1l} + 2[1-\lambda]ws_1 - 2cs_1 \\ &= \frac{2\lambda\beta}{2\beta - \gamma}\left\{\alpha_l w - [\beta - \gamma]w^2\right\} + [1-\lambda]\left\{\alpha_h w - [\beta - \gamma]w^2\right\} - [\alpha_h - [\beta - \gamma]w]c, \end{aligned} \tag{29}$$

after substituting from (26) and (28). The first-order condition with respect to w is

$$\frac{2\lambda\beta}{2\beta - \gamma}\left\{\alpha_l - 2[\beta - \gamma]w\right\} + [1-\lambda]\left\{\alpha_h - 2[\beta - \gamma]w\right\} + [\beta - \gamma]c = 0.$$

Re-arranging terms and simplifying, we have

$$\begin{aligned} w &= \frac{2\lambda\beta\alpha_l + [1-\lambda][2\beta - \gamma]\alpha_h + [2\beta - \gamma][\beta - \gamma]c}{2[\beta - \gamma][2\beta - [1-\lambda]\gamma]} \\ &= \frac{2\lambda\beta\alpha_l + [1-\lambda][2\beta - \gamma]\alpha_h}{2[\beta - \gamma][2\beta - [1-\lambda]\gamma]} + \frac{[2\beta - \gamma]}{2[2\beta - [1-\lambda]\gamma]}c. \end{aligned} \tag{30}$$

Substituting for w in (28), the stock is

$$s_1 = \frac{[2[1+\lambda]\beta - [1-\lambda]\gamma]\alpha_h - 2\lambda\beta\alpha_l}{4[2\beta - [1-\lambda]\gamma]} - \frac{[\beta-\gamma][2\beta-\gamma]}{4[2\beta-[1-\lambda]\gamma]}c. \tag{31}$$

In the Appendix, we show that, by (18), $s_1 \geq q_{1l}$. Substituting for w in (25),

$$p_{1l} = \frac{\alpha_l}{2\beta-\gamma} + \frac{2\lambda\beta^2\alpha_l + [1-\lambda][2\beta-\gamma]\beta\alpha_h + [2\beta-\gamma][\beta-\gamma]\beta c}{2[2\beta-\gamma][\beta-\gamma][2\beta-[1-\lambda]\gamma]}. \tag{32}$$

Substituting for w in (26),

$$q_{1l} = \frac{\beta\alpha_l}{2\beta-\gamma} - \frac{2\lambda\beta^2\alpha_l + [1-\lambda][2\beta-\gamma]\beta\alpha_h + [2\beta-\gamma][\beta-\gamma]\beta c}{2[2\beta-\gamma][2\beta-[1-\lambda]\gamma]}. \tag{33}$$

Substituting from (31) in (11),

$$p_{1h} = \frac{2\lambda\beta\alpha_l + [2\beta[3-\lambda] - 3[1-\lambda]\gamma]\alpha_h + [2\beta-\gamma][\beta-\gamma]c}{4[\beta-\gamma][2\beta-[1-\lambda]\gamma]}. \tag{34}$$

Full vis-à-vis No Returns

The following Table compares the profit-maximizing wholesale price, and equilibrium retail prices and quantities under the two scenarios of full and no returns. The difference in the manufacturer's profit in the two scenarios depends on a balance among the following:

- With returns, the wholesale price is higher and the retailers order larger stocks;
- However, with returns, in the event of low demand, retailers return unsold stock and the manufacturer must bear the cost of these items.

Table: Equilibrium with No and Full Returns[2] [3]

	No Returns		Full Returns
w	$\frac{1}{2}\left[\frac{[1-\lambda]\alpha_h}{\beta-\gamma}+c\right]$	$<$	$\frac{2\lambda\beta\alpha_l+[1-\lambda][2\beta-\gamma]\alpha_h}{2[\beta-\gamma][2\beta-[1-\lambda]\gamma]}+\frac{[2\beta-\gamma]}{2[2\beta-[1-\lambda]\gamma]}c$
$s_1 = q_{1h}$	$\frac{1}{4}[\alpha_h-\frac{\beta-\gamma}{1-\lambda}c]$	$<$	$\frac{[2[1+\lambda]\beta-[1-\lambda]\gamma]\alpha_h-2\lambda\beta\alpha_l}{4[2\beta-[1-\lambda]\gamma]}-\frac{[\beta-\gamma][2\beta-\gamma]}{4[2\beta-[1-\lambda]\gamma]}c$
p_{1l}	$\frac{\alpha_l}{2\beta-\gamma}$	$<$	$\frac{\alpha_l}{2\beta-\gamma}+$ $\frac{2\lambda\beta^2\alpha_l+[1-\lambda][2\beta-\gamma]\beta\alpha_h+[2\beta-\gamma][\beta-\gamma]\beta c}{2[2\beta-\gamma][\beta-\gamma][2\beta-[1-\lambda]\gamma]}$
q_{1l}	$\frac{\beta\alpha_l}{2\beta-\gamma}$	$>$	$\frac{\beta\alpha_l}{2\beta-\gamma}-$ $\frac{2\lambda\beta^2\alpha_l+[1-\lambda][2\beta-\gamma]\beta\alpha_h+[2\beta-\gamma][\beta-\gamma]\beta c}{2[2\beta-\gamma][2\beta-[1-\lambda]\gamma]}$
p_{1h}	$\frac{1}{4[\beta-\gamma]}\left[3\alpha_h+\frac{\beta-\gamma}{1-\lambda}c\right]$	$>$	$\frac{2\lambda\beta\alpha_l+[2\beta[3-\lambda]-3[1-\lambda]\gamma]\alpha_h+[2\beta-\gamma][\beta-\gamma]c}{4[\beta-\gamma][2\beta-[1-\lambda]\gamma]}$

For tractability, we focus on the case where the marginal cost of the product, $c = 0$. Substituting in (19),

$$\Pi_N = \frac{[1-\lambda]\alpha_h^2}{4[\beta-\gamma]}. \tag{35}$$

Substituting $c = 0$ in (29) and (30)

$$\Pi_R = \left\{\frac{2\lambda\beta}{2\beta-\gamma}\alpha_l + [1-\lambda]\alpha_h\right\}w - \frac{\beta-\gamma}{2\beta-\gamma}[2\beta-[1-\lambda]\gamma]w^2, \tag{36}$$

and

$$w = \frac{2\lambda\beta\alpha_l + [1-\lambda][2\beta-\gamma]\alpha_h}{2[\beta-\gamma][2\beta-[1-\lambda]\gamma]}. \tag{37}$$

Substituting (37) in (36) and simplifying, we obtain

[2] We omit the proofs of these results as they are mere algebraic substitutions. The exception is the proof that p_{1h} is higher with no returns. Equation (12) defines the price p_{1h} without and with returns. Since the stock is lower without returns, (12) implies that the price would be higher.

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

$$\Pi_R = \frac{[2\lambda\beta\alpha_l + [1-\lambda][2\beta-\gamma]\alpha_h]^2}{4[\beta-\gamma][2\beta-\gamma][2\beta-[1-\lambda]\gamma]}. \tag{38}$$

Comparing (38) with (35), the difference in the manufacturer's profit with and without returns, $\Pi_R - \Pi_N \geq 0$ if

$$\left\{ 2\lambda\beta\alpha_l + [1-\lambda][2\beta-\gamma]\alpha_h \right\}^2 - [1-\lambda][2\beta-\gamma][2\beta-[1-\lambda]\gamma]\alpha_h^2 \geq 0,$$

which simplifies to

$$2\lambda\beta\alpha_l^2 + [1-\lambda][2\beta-\gamma][2\alpha_l - \alpha_h]\alpha_h \geq 0. \tag{39}$$

Accordingly, we have the following result.

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

$$\frac{\alpha_h[\alpha_h - 2\alpha_l]}{\alpha_l^2} \leq \frac{2\lambda\beta}{[1-\lambda][2\beta-\gamma]}, \tag{40}$$

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

Retail Market Structure

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 no returns if the marginal cost of the product, $c = 0$ and the demand parameters satisfied the condition,

$$\chi \leq \frac{\lambda}{[1-\lambda]^{1/2} - [1-\lambda]}, \tag{41}$$

where $\chi \equiv \alpha_h / \alpha_l$. Using the same substitution, (40) can be simplified as

$$\chi^2 - 2\chi \leq \frac{2\lambda\beta}{[1-\lambda][2\beta-\gamma]},$$

or

$$[\chi - 1]^2 \leq \frac{2\lambda\beta}{[1-\lambda][2\beta-\gamma]} + 1, \tag{42}$$

or

$$\chi \leq \left[\frac{2\beta-\gamma+\lambda\gamma}{[1-\lambda]2\beta-\gamma+\lambda\gamma}\right]^{1/2} + 1 \equiv X(\lambda), \tag{43}$$

say.

Note that, with $\gamma = 0$,

$$X(\lambda) = \left[\frac{1}{1-\lambda}\right]^{1/2} + 1 = \frac{\lambda}{[1-\lambda]^{1/2} - [1-\lambda]}. \tag{44}$$

Further, the right-hand side of (42) is increasing in γ, and so, $X(\lambda)$ is increasing in γ, and thus, for $\gamma \geq 0$,

$$X(\lambda) \equiv \left[\frac{2\beta - \gamma + \lambda\gamma}{[1-\lambda]2\beta - \gamma + \lambda\gamma}\right]^{1/2} + 1 > \frac{\lambda}{[1-\lambda]^{1/2} - [1-\lambda]}. \tag{45}$$

Therefore, the condition (40) for the returns policy to increase the manufacturer profit when retailing is a duopoly is weaker than the corresponding condition (41) when retailing is a monopoly.

Concluding Remarks

Here, we have shown that, in a setting of end-user demand uncertainty and retail duopoly, a returns policy would 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. This shows that the returns policy serve *both* to dampen retail competition and resolve demand uncertainty.

Intuitively, the returns policy effectively sets a floor to the retail price when demand is low and so, attenuates price competition and raises the retailers' profits. This enables the manufacturer to set a higher wholesale price. Further, by eliminating any cost of excess inventory, the returns policy encourages retailers to order larger stocks.

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

By (26) and (28), with full returns, in the low demand state, retailers will leave some stock unsold, i.e., $s_1 \geq q_{1l}$ if

$$[\alpha_h - [\beta-\gamma]w][2\beta-\gamma] - 2[\alpha_l - [\beta-\gamma]w] = [2\beta-\gamma]\alpha_h - 2\beta\alpha_l + [\beta-\gamma]\gamma w \geq 0 .$$

Substituting from (30), this condition simplifies to

$$[2\beta-\gamma][4\beta-[1-\lambda]\gamma]\alpha_h - 2\beta[4\beta-2\gamma+\lambda\gamma]\alpha_l \geq \gamma[\beta-\gamma][2\beta-\gamma]c . \quad \text{(A1)}$$

By (18),

$$[2\beta-\gamma]\alpha_h - 4\beta\alpha_l \geq \frac{[\beta-\gamma][2\beta-\gamma]}{1-\lambda}c . \quad \text{(18)}$$

Now,

$$\begin{aligned}[2\beta-\gamma]\alpha_h - 4\beta\alpha_l &< [2\beta-\gamma][4\beta-\gamma+\lambda\gamma]\alpha_h - 4\beta[4\beta-\gamma+\lambda\gamma]\alpha_l \\ &< [2\beta-\gamma][4\beta-\gamma+\lambda\gamma]\alpha_h - 2\beta[4\beta-2\gamma+\lambda\gamma]\alpha_{l,}\end{aligned} \quad \text{(A2)}$$

and

$$\frac{[\beta-\gamma][2\beta-\gamma]}{1-\lambda}c > \gamma[\beta-\gamma][2\beta-\gamma]c . \quad \text{(A3)}$$

Substituting (A2) and (A3) in (18), we obtain (A1), which proves that $s_1 \geq q_{1l}$.