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WHAT MOTIVATES RETURNS POLICIES

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Abstract

We examine two different models of manufacturer-retailer successive monopoly with retail demand uncertainty. In the first, both manufacturer and retailer are symmetrically uninformed about demand. An equilibrium exists if and only if the marginal costs of production and storage are sufficiently high, in which case the manufacturer offers a full-returns policy. Together with previous results, this shows that both the structure of the uncertainty and the timing of its resolution are critical factors affecting the scope for returns policies. In the second model, the manufacturer knows demand while the retailer does not. A full-returns policy is never offered in this case. Moreover, if any partial-returns policy is offered, it does not serve to signal the level of demand.

Keywords: returns policies; demand uncertainty; pricing; successive monopoly.

J.E.L. Classifications: L12, L14

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1. Introduction

Supplier-distributor contracts must assign financial responsibility for unsold goods. In some industries manufacturers allow their distributors to return and obtain a full refund on unsold stock – this is known as a consignment contract. Such 'returns' policies are found in book, magazine, and newspaper publishing, as well as music recording, jewelry, and cigarettes.[1] In the computer distribution and reselling industry, where there is significant risk that stocks will become obsolete due to rapid technological innovation, often manufacturers offer a partial refund on unsold stock. Such practices have been the subject of a number of analyses attempting to identify conditions under which they are profitable for the manufacturer

While some have focused on the insurance benefits that returns policies offer retailers when there is demand uncertainty (Marvel and Peck, 1992; Lin, 1993), others have shown that returns policies give a manufacturer a strategic advantage by encouraging retailers to carry more stock (Pasternack, 1985; Pellegrini, 1986). Kandel (1996) canvases a range of possible motivations, showing formally that under successive monopoly and retail demand uncertainty that a full-returns policy – a refund equal to the input price paid by the retailer – is optimal for the manufacturer. Lastly, Padmanabhan and Png (1997) show that a returns policy can also provide the manufacturer with a strategic benefit when there is retail competition, even in the absence of demand uncertainty. It induces more competitive behavior from the retailers, thus encouraging them to carry more stock.

Because of the diverse approaches that have been adopted in studying this topic, no clear picture has yet emerged of the relative significance of the various explanations above. Achieving such an understanding will likely require, in addition to empirical evidence, further theoretical analysis in order to establish the robustness of the above results. This paper takes a step in that direction by testing the robustness of the results of the latter two studies above by examining different and, in our view, more realistic settings.[2]

In contrast to Padmanabhan and Png (hereafter PP), we assume throughout that demand uncertainty is resolved *after* the retail price is set. PP assume that, although the retailer is uncertain about retail demand when ordering stocks, this uncertainty is resolved prior to setting the retail price. One interpretation is that a significant period of time elapses between the ordering and pricing of stock by the retailer – enough time for accurate retail demand information to be revealed. However, stock is often delivered quickly and thus the retailer has no more information when pricing than ordering. While this is clearly true for newspapers and magazines, demand is likely to be well known for such repeat purchase items anyway. On the other hand, for novel goods (e.g., a new paperback novel or CD), it will be difficult for the retailer to glean information about demand for the product prior to it being put on the shelves (i.e., before the price is set). We also focus throughout on successive monopoly in manufacturing and retailing.

We consider two different models. The distinguishing feature of the first model is that the manufacturer and retailer are *symmetrically* uninformed about whether retail demand is high or low. The second model introduces *asymmetric* information – the manufacturer knows the actual retail demand while the retailer does not. This is plausible for novel products, as the manufacturer will be better informed at the outset about product characteristics than the retailer. For example, a publisher, through its editors, will initially be better informed about the quality or appeal of a novel than a retailer who sells this title. Moreover, the manufacturer has more incentive to carry out market research if the product constitutes a larger fraction of their sales than it does of the retailer's sales.

In the first model we show that the retailer's profit-maximization problem has a solution if and only if both the level and probability of high demand are sufficiently low relative to the marginal costs of production and inventory storage.[3] Hence, precisely the same conditions must hold in order for an equilibrium to exist. We conclude that under plausible conditions – low marginal costs of production and storage – the symmetric information model has no predictive power. This may indicate that the model is ill suited to explaining returns policies.[4] The result also shows that the results of PP – who encounter no such existence problems – are not robust to changes in the timing of resolution of the demand uncertainty. While this sensitivity of the equilibrium to the precise informational structure is not surprising, the result commands attention simply because our informational structure is, in our view, more compelling than that of PP.

We then show that if there does exist an equilibrium, it cannot involve a no-returns policy (i.e., zero refund). This result is essentially a by-product of the requirements for existence of an equilibrium – a no-returns policy ensures that the retailer's pricing problem has no solution. Second, while the model structure does not in principle preclude the possibility of a partial refund in equilibrium, it turns out that precisely the same conditions required for existence of equilibrium also rule out the possibility of a partial-refund. Thus, any equilibrium involves the manufacturer offering a full-returns policy (i.e., a refund equal to the wholesale price).

While other authors have also found that a full-returns policy is optimal for the manufacturer, our rationale differs. Neither the retailer's optimal price nor stock is a function of the wholesale price here. The retail and wholesale pricing decisions are independent simply because the retailer commits to an amount of stock before setting the retail price. The fact that the stocking decision is independent of the wholesale price is more surprising. The reason is that the retailer's profit is increasing and convex up to some threshold level of stock, while decreasing beyond this threshold. Hence, this threshold level is the retailer's profit-maximizing stock. We show that it is independent of the wholesale price and *decreasing* in the refund.

Thus, in contrast to PP, the manufacturer does not offer a full-returns policy for the purpose of inducing the retailer to carry more stock – that is, to mitigate the double marginalization problem. From above, we know that increasing the refund actually *exacerbates* this problem. Rather, the reason for a full-returns policy is that it allows the manufacturer to charge a higher wholesale price. The benefit to the manufacturer from charging a higher wholesale price turns out to be greater than the cost of offering the refund. While Kandel offers a similar rationalization for offering a full-returns policy, the retailer's stocking level *does* depend on the wholesale price in his model, reflecting a fundamentally different equilibrium structure.

In the second model, involving asymmetric information, we show that there is no equilibrium in which the manufacturer offers a full-returns policy. This is the opposite result to that established in the first model, where a full-returns policy was shown to be the *only* possible equilibrium. In order to explain this result, it is easiest to distinguish between separating and pooling equilibria.

It is straightforward to see why a returns policy will not be offered in a separating equilibrium. Clearly there is no role for a returns policy if retail demand is known perfectly, since in this case the retailer never carries excess stock – they simply order to demand. However, this is precisely the situation in a separating equilibrium – the demand state is signaled to the retailer through the manufacturer's pricing policy, thus resolving the retailer's uncertainty. While the manufacturer could offer a refund on returned stock, such a policy would clearly be redundant since no stock is in fact returned – it is more natural to assume instead that no refund is offered.[5]

In a pooling equilibrium, the structure from the retailer's perspective is identical to that in the symmetric information model – in both cases they are unaware of the true demand and respond to a single manufacturer strategy (since both types of manufacturer choose the same strategy in a pooling equilibrium). Moreover, since existence of equilibrium in the first model rests entirely on the structure of the retailer's problem, existence of a pooling equilibrium is governed by exactly the same conditions as those identified in the first model. One of the properties we establish in the first model is that in any equilibrium there is zero demand in the low demand state. In other words, the retailer returns their entire stock to the manufacturer when demand turns out to be low. Clearly, if the refund equals the wholesale price (i.e., a full returns policy is offered) and the good is costly to produce, then a 'low-demand' manufacturer incurs losses by offering a full-returns policy. Thus, a full-returns policy is never offered in a pooling equilibrium.

We also show that a no-returns policy cannot be offered in a pooling equilibrium. The intuition is identical to that in the symmetric information model – this follows from the above-mentioned similarity of the structure of the retailer's strategy in a pooling equilibrium to that in the symmetric information model. This result, together with the finding that no refunds are offered in separating equilibria, leaves pooling partial-returns policies as the only possible type of equilibrium refund. We do not attempt to establish the conditions supporting such policies nor give a characterization of the equilibria.[6]

The above results can be viewed as a comment on Kandel's intuition regarding the role of demand information asymmetries in explaining returns policies. He offers two arguments, the first being premised on the view that, because most new products are market failures, the manufacturer will typically be more optimistic than the retailer about their product's likely success. Thus, the manufacturer's perceived cost of offering a returns policy will be lower than the retailer's perceived benefit, meaning that there can be mutual gains from introducing such a policy. However, the divergent belief approach to modeling has been largely ignored by economists, who have instead embraced the asymmetric information paradigm that we adopt here.[7] Kandel's second, alternative argument (in footnote 33), which is consistent with our approach, asserts that not offering a full-returns policy will signal to the retailer that demand is low.[8] Thus, manufacturers offer a returns policy in order to dispel this belief. While this signaling role arises in our model, we show that it does *not* guarantee that returns policies are offered in equilibrium. In fact, we show that they are *never* offered.

In the next section we outline the symmetric information model, which we then analyze in section 3. The asymmetric information model is introduced and analyzed in section 4, followed by concluding comments in section 5.

2. Model

A manufacturer sells a good to a retailer, both being risk neutral and monopolists in their market.[9] A static (one-shot) setting is considered. Both parties employ uniform prices – that is, they don't use two-part tariffs or nonlinear pricing schedules. Retail demand is of the form $q = a_i - \beta p$, where p is the retail price and $\beta > 0$. Both retailer and manufacturer are symmetrically uninformed about the true state of demand, it being either high or low: $i \in \{\ell, h\}$, $a_\ell < a_h$. Both parties believe that demand will be high with probability $\lambda \in (0,1)$.

The manufacturer has a constant marginal cost of production, c, but no fixed costs. The retailer has a constant marginal cost of inventory storage, s. The retailer serves a pure distribution function, undertaking no manufacturing activities. The salvage value of the good is assumed to be zero for both manufacturer and retailer.[10] The time line is as follows.

$t = 1$: The manufacturer sets the wholesale price, w, and the refund, r.

$t = 2$: The retailer orders its stock, q.

$t = 3$: The retailer sets the retail price, p.

$t = 4$: Demand is realized and returns occur if necessary.

The manufacturer is assumed to be able to commit to the returns policy that it offers. We solve for the subgame perfect equilibrium in this setting.

3. Symmetric Information

Each decision is analyzed in a separate subsection. Applying backwards induction, we start with the last decision first.

3.1 Retail Pricing

Since stocks are purchased before the retailer sets its price, both the cost of the stock, w, and the inventory storage cost, s, are sunk at the time the retailer chooses its price – they are irrelevant to the determination of the retailer's optimal price, p^*. However, the refund, r, for returned stock affects the optimal retail price since a higher refund reduces the pressure on the retailer to sell to consumers (i.e., supports a higher retail price).

The retailer chooses p to maximize profit conditional on the level of stocks, q. Letting expected demand conditional on stocks be denoted by[11]

$$D(p|q) \equiv \lambda \min\{a_h - \beta p, q\} + (1-\lambda)\min\{a_l - \beta p, q\},$$

it follows that

$$\pi^r(p|q) = D(p|q)p + [\lambda \max\{0, q - a_h + \beta p\} + (1-\lambda)\max\{0, q - a_\ell + \beta p\}]r.$$

Since we do not know *a priori* whether the optimal level of stocks will be binding in both the high and low demand states, only the high demand state, or in neither state, we need to consider these cases separately. First, suppose that stocks are never binding. That is, regardless of whether demand is high or low, at the chosen price there are enough stocks to serve the entire demand. Since profit in this case is given by

$$\pi^r(p|q) = [\lambda(a_h - \beta p) + (1-\lambda)(a_\ell - \beta p)](p - r) + qr,$$

which is concave in p, it follows, letting $\bar{a} \equiv \lambda a_h + (1-\lambda)a_\ell$, that the profit-maximizing price is

$$p^* = p_1 \equiv \frac{\bar{a} + \beta r}{2\beta}. \tag{1}$$

Not surprisingly, p^* is positively related to the refund. This is because the retailer's outside option to selling becomes more profitable as r increases, implying that a higher price must be paid in the market in order to make it worth selling, rather than returning, the good. Note also that p^* is independent of the level of stocks, q. This is because the retailer's decision problem at the margin remains unchanged as stocks vary – the incentive to increase the retail price depends on the magnitude of the refund, not how much stock is on hand.

Equation (1) defines the optimal price for any level of stocks higher than the high level of demand at p_1, given by $a_h - \beta p_1$. Thus, Equation (1) holds for all

$$q \geq q_1 \equiv a_h - \beta p_1 = \frac{1}{2}[2a_h - \bar{a} - \beta r].$$

In the case where stocks are binding only in the high demand state,

$$\pi^r(p|q) \;=\; [\lambda q \;+\; (1-\lambda)(a_\ell - \beta p)]\,p + (1-\lambda)[q-(a_\ell - \beta p)]r\,.$$

Since this expression is concave in p, the function describing the profit-maximizing price is given by

$$\hat{p}(q) \;=\; \frac{1}{2}\left(r + \frac{\lambda q + (1-\lambda)a_\ell}{\beta(1-\lambda)}\right) \tag{2}$$

As stocks increases, there is an incentive to increase the price since the retailer knows it won't affect demand in the high demand state. Although this exacerbates the surplus in the low demand state, this is being reimbursed at a fixed rate r anyway. Thus, comparing Equations (1) and (2), there are important differences between the retailer's pricing incentives when stocks are never constraining versus when they are constraining in the high demand state.

An important implication of these differences is that there is no reason to expect that the highest level of stocks, q_3, such that stocks are binding only in the high demand state when pricing according to Equation (2) will equal the lowest level of stocks, q_1, such that stocks are not binding in either state when pricing at p_1. This fact lies at the core of many of the results in this section. The solution to q_3 is given by the intersection of the high demand function with Equation (2). That is,

$$\frac{1}{2}\left(r + \frac{\lambda q_3 + (1-\lambda)a_\ell}{\beta(1-\lambda)}\right) \;\equiv\; \frac{1}{\beta}[a_h - q_3],$$

implying

$$q_3 \;=\; \frac{1-\lambda}{2-\lambda}[2a_h - a_\ell - \beta r]\,.$$

There are two possibilities: either $q_3 < q_1$ or $q_3 \geq q_1$. We first show that if $q_3 < q_1$, then for all $q \in [q_3, q_1]$ the retailer's optimal pricing strategy has no solution.

Lemma 1. *If $r < \bar{a}/\beta$, the profit-maximizing strategy of the retailer is not well defined. Hence, there exists no equilibrium.*

We begin by noting that the inequalities $q_3 < q_1$ and $r < \bar{a}/\beta$ are formally equivalent. The non-existence of an optimal price rests on the fact that there are only two possible solutions: p^* is described either by $\hat{p}(q)$ or p_1. However, under the stated condition $\hat{p}(q)$ is so high over the interval $[q_3, q_1]$ that there is excess supply (i.e., stocks exceed demand) even in the high demand state. But this violates the key premise underlying the optimality of $\hat{p}(q)$ – that there is excess demand in the high demand state. On the other hand, p_1 cannot be the profit-maximizing price for any $q \in [q_3, q_1]$ because this price induces excess demand in the high demand state. Again, this also violates the key premise underlying the optimality of p_1 – that there is always excess supply. This argument is illustrated in Figure 1(a) below. Clearly, if the retailer's optimal strategy is not well defined then nor is the manufacturer's strategy, implying that there does not exist an equilibrium.

Corollary 1. *There exists no equilibrium in which the manufacturer offers a no-returns policy. That is,* $r^* \neq 0$.

This result follows straightforwardly from Lemma 1 and the fact that $\bar{a}/\beta > 0$. It remains to characterize any equilibria that do exist. In particular, do they involve full-, partial-, or no-returns policies? The subsequent analysis is directed at answering this question. In order to ensure that $r \geq \bar{a}/\beta$ is indeed satisfied for all equilibria we subsequently analyze, it is necessary to check that they are consistent with the setting described in Figure 1(b), not that in Figure 1(a).

In order to complete our analysis of retailer pricing, it is necessary to consider the case where stocks are binding in both demand states. This is true if

$$q \leq a_\ell - \beta\hat{p}(q).$$

Letting q_2 denote the highest level of stocks such that this is true gives

$$q_2 = \frac{(1-\lambda)[a_\ell - \beta r]}{2-\lambda}. \tag{3}$$

If $q_2 > 0$, then it is necessary to consider all $q \in [0, q_2]$, in which case $\pi^d(p;q) = qp$.

The following result establishes that this is not a case that we need to consider.

Lemma 2. *If there exists an equilibrium, then $q_2 < 0$. Furthermore, demand in the low demand state is zero in any equilibrium.*

To conclude, if an equilibrium exists, then the retailer's optimal pricing policy is described by the heavy line in Figure 1(b).

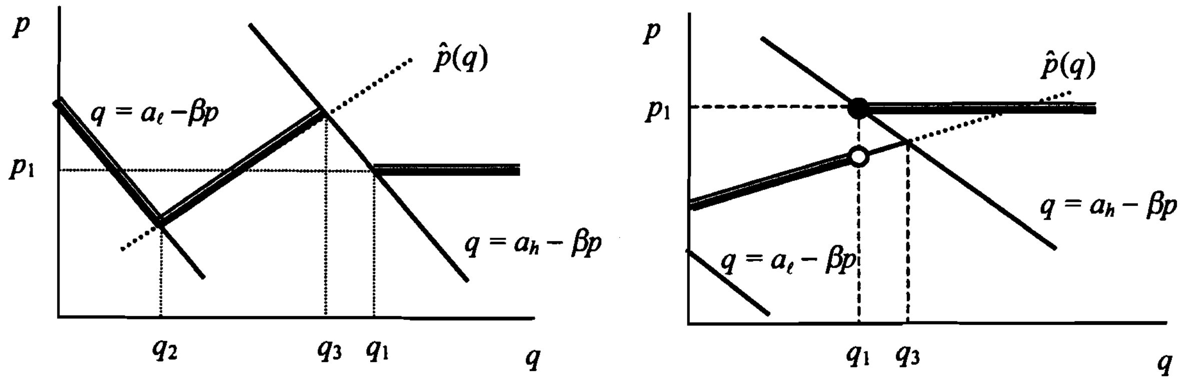

Figure 1(a): $r < \bar{a}/\beta$. Figure 1(b): $r \geq \bar{a}/\beta$.

3.2 Retail Stocks

Now that we have identified the retailer's optimal pricing strategy, $p^*(q)$, we next analyze their profit maximizing choice of stock, q^*. We begin by imposing restrictions on the magnitude of the refund that the manufacturer offers.

Assumption 1. $0 \leq r \leq w$.

We make the realistic dual assumptions that the manufacturer cannot require the retailer to pay in order to return stock and neither do they offer a refund that is higher than the wholesale price initially charged for the good. The former assumption is innocuous, since a rational retailer who can freely dispose of stock will never pay the manufacturer for the same service. The second assumption also seems natural – it is hard to imagine a manufacturer refunding more than the original sale price on a product. Note that it also rules out the possibility of a retailer arbitraging the margin when the refund is higher than the wholesale price, thereby making unlimited profit by ordering and returning an infinite amount of stock.

We begin by establishing that over the range $q \geq q_1$, the profit-maximizing level of stock is q_1. Since demand is zero in the low demand state when the price is p_1 (see Lemma 2), the retailer's profit for $q \geq q_1$ is given by

$$\pi^{r}(q) = \lambda(a_h - \beta p_1)\, p_1 + \big(\lambda[q - a_h + \beta p_1] + (1-\lambda)[q - a_\ell + \beta p_1]\big)r - (w+s)q.$$

Also, since

$$\pi_q^{r} = r - (w+s) < 0,$$

the retailer maximizes profit by choosing the lowest level of stock in the interval: $q^* = q_1$. The intuition is that when $q \geq q_1$, the retailer returns stock in both high and low demand states. Since the optimal price, p_1, is independent of the level of the stock, purchasing more stock has no effect on the retailer's revenues from sales. Rather, it means only that more stock will be returned to the manufacturer. Provided that the refund is lower than the sum of the wholesale price and the storage cost, which is true by virtue of Assumption 1, it follows immediately that the retailer maximizes profit by choosing the lowest level of stock in the range under consideration, q_1.

It remains only to analyze profits over the interval $q \in [0, q_1)$, in which case we know the retailer prices according to $\hat{p}(q)$. Recall that stocks are constraining only in the high demand state in this case, while demand is always zero in the low demand state. Thus, the retailer's expected profit is

$$\pi^{r}(q) = \lambda q \hat{p}(q) + (1-\lambda) q r - (w+s) q.$$

Also,

$$\pi_q^{r} = \lambda[\hat{p}(q) + \hat{p}'(q) q] + (1-\lambda) r - (w+s),$$
$$\pi_{qq}^{r} = 2\lambda \hat{p}'(q) > 0.$$

Since the retailer's profit is convex, it is maximized at either $q = 0$ or $q = q_1$. Clearly profit is zero at $q = 0$, so if $\pi^{r}(q_1) \geq 0$ then we know that q_1 is the profit-maximizing level of stocks. Recalling that p_1 is the profit maximizing price at q_1,

$$\pi^{r}(q_1) \quad = \quad [\lambda p_1 + (1-\lambda)r - w - s]q_1.$$

Hence, $\pi^{d}(q_1) \geq 0$ if and only if[12]

$$r \quad \geq \quad \frac{2}{2-\lambda}\left(w + s - \frac{\lambda \bar{a}}{2\beta}\right). \tag{4}$$

Since an equilibrium in which the retailer purchases no stock is not interesting, henceforth we assume Equation (4) to be satisfied. Thus, both the retailer's optimal stocking level and price are independent of the wholesale price.

3.3 Manufacturer Pricing

We now derive the manufacturer's optimal strategy, (w^{*}, r^{*}). By virtue of Lemma 2 and the analysis above establishing that $q^{*} = q_1$, the manufacturer's profit is given by

$$\pi^{m}(w,r) \quad = \quad [w - c - (1-\lambda)r]\, q_1. \tag{5}$$

Since $\pi^{m}_{w}(w, r) = q_1 > 0$, the manufacturer should set w as high as possible. This is not surprising since w does not affect the manufacturer's sales, q_1. However, clearly the retailer cannot be forced to bear negative profits, implying that the manufacturer should maximize w subject to satisfying $\pi^{d}(w; q_1) \geq 0$. Rearranging Equation (4) gives

$$w^{*}(r) \quad = \quad \frac{2-\lambda}{2}r \; + \; \frac{\lambda \bar{a}}{2\beta} \; - \; s. \tag{6}$$

Substituting Equation (6) into Equation (5) allows us to express the manufacturer's profit as a function only of the refund, r. Differentiating with respect to r gives

$$\pi^{m}_{r} \quad = \quad \left(\frac{2-\lambda}{2}r + \frac{\lambda \bar{a}}{2\beta} - s - c\right)\frac{\partial q_1}{\partial r} \; + \; \frac{2-\lambda}{2}q_1 \; - \; (1-\lambda)\left(\frac{\partial q_1}{\partial r}r + q_1\right),$$

$$\pi^{m}_{rr} \quad = \quad \lambda \frac{\partial q_1}{\partial r} \quad < \quad 0.$$

Since the manufacturer's profit is concave, assuming an interior solution, the profit maximizing refund solves $\pi_r^m(r') = 0$ and is given by

$$r' \;=\; \frac{1}{\beta}[a_h - \bar{a}] \;+\; \frac{2}{\lambda}[s + c] \;>\; 0. \tag{7}$$

The result that $r' > 0$ may seem unexpected, since we know that increasing the refund lowers the quantity that the manufacturer sells: $\partial q_1/\partial r < 0$. The reason that the manufacturer prefers a positive refund is that it increases the retail price, since $\partial p_1/\partial r > 0$, which in turn increases the retailer's profits. This is turn allows the manufacturer to levy a higher wholesale price on the retailer. At low refunds, this positive effect on the manufacturer's profits due to increasing the refund outweighs the above negative effect. Our first main result is summarized in the following proposition.

Proposition 1. *There exists an equilibrium if and only if the level, a_h, and the probability, λ, of high demand are sufficiently small relative to the marginal costs of production and storage, s and c, and the demand slope, β. The unique equilibrium involves the retailer being fully refunded for their unsold stock.*

Our analysis can be viewed as bolstering previous findings that the manufacturer's optimal strategy is to fully refund returned stock. Butz (1997) suggests that a full-returns policy can be a useful, perhaps necessary, tool for inducing retailers to charge the manufacturer's recommended retail price. As our retailer is a monopolist, this rationale is clearly not applicable to our setting.

Kandel, whose model differs from ours in the structure of both market demand and uncertainty, also establishes that the manufacturer prefers full-return contracts.[13] In his model, an increase in the refund has two effects on the manufacturer's profit: (i) it increases since a higher refund allows a higher wholesale price to be charged, and (ii) it decreases due to the associated increase in refunds to the retailer. Kandel shows that the former effect dominates the latter for any given level of stock. A similar tradeoff is involved here – both (i) and (ii) come into play. However, we observe a third effect: the retailer's stocking level decreases, and thus also the manufacturer's profit, as the refund increases.

While analyzing downward sloping demand in Kandel's model is difficult, he asserts that a no-returns policy is optimal if the demand elasticity is sufficiently high. Our analysis establishes that this is not true if the demand uncertainty is *discrete* rather than continuous – a no-return policy is *never* optimal in our model. This suggests that the approach to modeling demand uncertainty is not innocuous.

PP's model (in section 6) differs from ours only in the timing of revelation of demand.[14] They find that a full-return policy has both benefits and costs for the manufacturer. On the one hand it encourages the retailer to increase their level of stock, which lowers the retail price and thus mitigates the double-marginalization problem. On the other hand it gives the retailer an incentive to order stock with a view only to accommodating the high demand state, resulting in over-production by the manufacturer. Depending on the relative strength of these forces, either a full-return or no-return policy can be optimal.

We observe precisely the opposite, as an increase in the refund *increases* the retail price and *decreases* the retailer's stock in our model. Not only is the structure of equilibrium different in the two models, but the conditions we identify as supporting a full-returns policy also differ. Moreover, PP shows that no-returns policies can occur in equilibrium (if a_h/a_ℓ is sufficiently high), while this is never true in our model. Thus, our analysis serves to put PP's results in better perspective, since we show how importantly their results rely on the assumption that demand information is revealed *before* retail pricing. As argued earlier, there is a large class of cases for which our timing structure seems more plausible.

Another important difference between our analysis and the above two analyses is that a complete explanation of our results is intrinsically linked to issues surrounding existence of equilibrium. The fact that no-returns and partial-returns policies cannot occur in equilibrium here is more an artifact of the equilibrium structure of our model than it is of the raw incentives facing the manufacturer.

One striking feature of Proposition 1 is that the conditions required for existence of equilibrium seem unlikely to hold for many markets in which returns policies are observed. That is, the marginal costs of production and storage of products such as books, magazines and CD's are very low. Since it is difficult to motivate strategies if they cannot be shown to occur in equilibrium, it could be argued that our model is not appropriate for explaining returns policies in many industries. In particular, some rationale other than retail demand uncertainty may be the key driver behind returns policies.

4. Asymmetric Information

4.1 Motivation

The model above is arguably unrealistic in assuming that the manufacturer and retailer are *equally* uninformed about retail demand. We address this deficiency in this section by allowing for the manufacturer to be better informed about demand than the retailer. This particular type of asymmetry is motivated by the view that it will typically be the manufacturer, rather than the retailer, who will conduct market research prior to the production and marketing of the good. While the retailer will gradually learn about retail demand for repeat purchase goods, in the case of novel goods the manufacturer is likely to be better informed than the retailer at the outset.

4.2 Model

We make only one change to the model in section 3: the manufacturer is now assumed to know whether demand is high or low (as before the retailer believes that demand will be high with probability λ). Following the usual approach to solving Bayesian games, we model strategies for both the high and low demand types of manufacturer, denoting their strategies by (w_h, r_h) and (w_ℓ, r_ℓ) respectively. We extend Assumption 1 to apply to both types of manufacturer: $r_i \leq w_i$ for $i \in \{\ell, h\}$. Also, if the manufacturer is indifferent between two refunds, they offer only the lower refund. Separating and pooling equilibria are discussed separately.

4.3 Separating Equilibrium

We now establish that a full-returns policy cannot be offered in a separating equilibrium.

Proposition 2. *In any separating equilibrium, both types of manufacturer offer a no-returns policy. That is,* $r_h^* = r_\ell^* = 0$.

Note that Proposition 2 also rules out the possibility of partial refunds occurring in a separating equilibrium. In a separating equilibrium, by definition, the high and low demand manufacturers adopt different strategies. The retailer is thus able to learn the true state of demand simply by observing the prices offered by the manufacturer. But a returns policy serves no purpose when the retailer is fully informed about demand since they know precisely how much stock to order in this case. Hence, a returns policy has no role to play in a separating equilibrium.

It follows that if a returns policy is offered, it must be in the context of a pooling equilibrium. This gives us the following corollary to Proposition 2.

Corollary 2. *If a returns policy is offered, then both types of manufacturer offer identical policies. That is, returns policies do not serve a signaling role.*

While Kandel has proposed that a returns policy signals that a manufacturer has a high demand product, Corollary 2 clearly refutes this conjecture. It might be argued that the strength of this result derives directly from the simplistic way in which we model the structure of uncertainty. Since the retailer is perfectly informed about the specification of both the high and low demand schedules, in a separating equilibrium there is no residual uncertainty. If instead the retailer is uncertain about the structure of both the high and low demand functions, then it may appear that a role remains for returns policies in a signaling equilibrium. However, if the uncertainty is of the same type as that modeled above – the retailer believes each demand function has two (or any finite number of) possible intercepts – then Corollary 2 remains true. Instead of having two types of manufacturer, this simply extends the model to four types and the same intuition applies.

We now turn to examine pooling equilibria in order to determine whether full-returns policies can arise in this setting.

4.4 Pooling Equilibrium

We focus here on identifying equilibria that involve either a no-returns or a full-returns policy. This is sufficient to allow us to answer the question of whether incomplete information can motivate manufacturers to offer full-returns policies, while allowing us to avoid the complexities of equilibria involving partial-returns policies.

In any pooling equilibrium $(w_h^*, r_h^*) = (w_\ell^*, r_\ell^*)$, implying that the retailer learns nothing about the state of demand from observing the wholesale price and refund. Thus, the derivation of (p^*, q^*) in a pooling equilibrium parallels that in section 3, implying that no stock is returned to the high demand manufacturer while all stock is returned to the low demand manufacturer in any pooling equilibrium – see Figure 1(b). This gives us the following result.

Proposition 3. *There exists no pooling equilibrium in which either a full-returns or a no-returns policy is offered.*

The fact that a no-returns policy cannot be offered in a pooling equilibrium follows immediately from Corollary 1. On the other hand, a full-returns policy ensures that the low demand manufacturer makes negative profits – they incur positive production costs but make zero sales revenue (net of refunds). A low demand manufacturer has no incentive to participate in such a pooling equilibrium. Thus, if a returns policy is offered, it must be a partial-returns policy identical to both types of manufacturer.

5. Conclusion

We have examined two different settings both of which focus on demand uncertainty – one in which information is symmetric, the other in which it is asymmetric. The goal has been to obtain a deeper understanding of the role of demand uncertainty in manufacturers' returns policies. Taken together with previous studies, our results indicate that while demand uncertainty alone can be sufficient to motivate returns policies, the precise structure of the uncertainty and the timing of its resolution critically affect the scope for, and nature of, returns policies in equilibrium. We also show that, contrary to previous conjecture, returns policies do not serve as a mechanism to signal to retailers the level of demand for the product. Moreover, full-returns policies are never offered in an asymmetric setting. This suggests that demand information asymmetries are unlikely to explain why manufacturers offer commonly observed (i.e., full-) returns policies.

One obvious possible extension to our model would be to allow retailers to choose from among a number of products from competing manufacturers. Also, allowing for retail competition would clearly increase the plausibility of the model. If in fact the true motivation for returns policies lies in strategic considerations due to horizontal (as opposed to vertical) competition, then such extensions will inevitably be required.

Another avenue of research that has not been explored is the possibility that returns policies solve a moral hazard problem. If the manufacturer forces the retailer to bear responsibility for unsold stock, while they benefit from not having to bear the associated risk, the manufacturer suffers a loss of control in the sense that they now rely on the retailer to voluntarily disclose sales data. This information is likely to be of value if the manufacturer is planning to produce similar products in the future. Similarly, the information will be of strategic value to the retailer since by understating sales they are able to obtain stock at a lower price to reflect the (apparent) corresponding higher risk of having unsold stock. Clearly, however, research along these lines requires the development of a dynamic model of the manufacturer-retailer relationship.

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Appendix

Proof of Lemma 1.

If $q_3 < q_1$, then $\forall q \in [q_3, q_1]$ we have $p^*(q) \in \{\hat{p}(q), p_1\}$. That is, demand either exceeds stocks in the high demand state, in which case $p^*(q) = \hat{p}(q)$, or stocks exceed demand, in which case $p^*(q) = p_1$. Suppose $p^*(q) = \hat{p}(q)$. However, since $\hat{p}'(q) > 0$, it follows immediately from the definition of q_3 that stocks exceed demand in the high demand state in this case, thus contradicting the optimality of $\hat{p}(q)$.

Similarly, if $p^*(q) = p_1$, then, since $q_3 < q_1 \Leftrightarrow q(p_1; a_h) > q, \forall q \in [q_3, q_1]$, it follows that demand exceeds stocks in the high demand state. Again, this contradicts the optimality of p_1. Finally, note that $q_3 < q_1 \Leftrightarrow \bar{a} > \beta r$. ■

Proof of Lemma 2.

Lemma 1 establishes that an equilibrium exists iff $r \geq \bar{a}/\beta$. Also, it follows from Equation (3) that $q_2 > 0 \Leftrightarrow r < a_\ell/\beta$. Since, by construction, $\bar{a} \geq a_\ell$, it follows that an equilibrium exists only if $q_2 < 0$.

To show that demand in the low demand state is zero in equilibrium, first note that demand is given by $\max\{0, a_\ell - \beta p\}$. There is no need to consider $q < q_2$ since $q_2 < 0$. For stocks $q \in [q_2, q_1)$, the optimal price is described by $\hat{p}(q)$. Now, by definition, we have $a_\ell - \beta\hat{p}(q_2) < 0$. Since $\hat{p}'(q) > 0$, for all $q \in (q_2, q_1)$, we have $a_\ell - \beta\hat{p}(q) < 0$. For $q \geq q_1$, we have $p^* = p_1$.[1] It is straightforward to show that $p_1 \geq \hat{p}(q_1) \Leftrightarrow r \geq \bar{a}/\beta$, while Lemma 1 shows that latter to be necessary for existence of an equilibrium. Therefore, again we have that $a_\ell - \beta p_1 < 0$. Thus, in equilibrium demand in the low demand state is always zero. ■

Proof of Proposition 1.

Since an interior solution requires $r' < w^*(r')$, Equation (7) implies that the profit maximizing refund is given by

$$r^* = \begin{cases} r' & \text{if} \quad (\lambda/2)[(2\lambda - 1)a_h + 2(1-\lambda)a_\ell] > \beta(s+c), \\ w^*(r') & \text{otherwise.} \end{cases}$$

Suppose $(\lambda/2)[(2\lambda - 1)a_h + 2(1-\lambda)a_\ell] > \beta(s+c)$, so that $r^* = r'$. Using Equation (7), existence of an equilibrium requires

$$\begin{aligned} && r' &\geq \bar{a}/\beta \\ \Leftrightarrow && \beta(s+c) &\geq (\lambda/2)[(2\lambda - 1)a_h + 2(1-\lambda)a_\ell] \end{aligned}$$

[1] At q_1 the retailer strictly prefers pricing at p_1 rather than $\hat{p}(q_1)$ -- in both cases all stock is refunded when demand is low since $q_2 < 0$. That is, pricing higher doesn't diminish sales, and thus unambiguously increases revenues.

It follows immediately that there exists no equilibrium under the presumed condition, thus proving the necessity of the conditions stated in the proposition.

Suppose instead that $r^* = w^*(r')$. Using Equations (6) and (7), existence of an equilibrium requires

$$w^*(r') \;\geq\; \bar{a}/\beta$$

$$\Leftrightarrow \quad \lambda\left[(2-5\lambda+\lambda^2)a_h - (1-\lambda)(4-\lambda)a_\ell\right] \;\geq\; -2\beta[2(1-\lambda)s+(2-\lambda)c].$$

Since $a_h > a_\ell$, this condition holds for all a_h and λ sufficiently small relative to s, c and β. This establishes sufficiency of the stated conditions. The second statement follows immediately. ■

Proof of Proposition 2.

In any separating equilibrium, $(w_h^*, r_h^*) \neq (w_\ell^*, r_\ell^*)$. Thus, after observing the manufacturer's strategy, the retailer knows whether demand is high or low and thus update their prior belief accordingly: $\lambda \in \{0, 1\}$. For all $0 \leq r_i \leq w_i$, the retailer purchases an amount of stock $q^* = [a_i + \beta r_i]/2$, all of which is sold with certainty. Thus, since no stock is ever returned, the manufacturer is indifferent between all $0 \leq r_i \leq w_i$. By, assumption, the manufacturer chooses $r_i^* = 0$. ■

Proof of Proposition 3.

The profit of the low-demand manufacturer in a pooling equilibrium is given by

$$\pi_p^\ell(w_p, r_p) \;=\; [w_p - c]q_1 - [q_1 - \max\{0, a_\ell + \beta p_1\}]r_p.$$

However, recall that any equilibrium satisfies $a_\ell - \beta p_1 < 0$. Thus, if $w_p^* = r_p^*$, then profit is given by

$$\pi_p^\ell(w_p^*, r_p^*) \;=\; [w_p^* - r_p^* - c]q_1 \;<\; 0.$$

Since the low-demand manufacturer can obtain zero profit by setting w_p^* arbitrarily high, it follows immediately that there exists no pooling equilibrium satisfying $w_p^* = r_p^*$.

The non-existence of a pooling equilibrium in which $r_p^* = 0$ follows immediately from Corollary 1. ■

Endnotes

[1] See Kandel (1996) for other examples.

[2] Unlike Butz (1997) and others, we are not concerned here with the related issue of whether a returns policy serves as a substitute for vertical integration or retail price maintenance.

[3] If these conditions are not satisfied, there exists a range of stocking levels over which there is no profit-maximizing price.

[4] An alternative interpretation is that actual returns policies are rarely optimizing in the sense of being equilibrium strategies.

[5] This assumes that the refund is not higher than the retailer's net (wholesale price plus storage) cost of obtaining the stock. This is a natural assumption – in its absence the retailer will arbitrage the manufacturer and make unbounded profit while imposing unbounded losses on the manufacturer.

[6] This would greatly increase the length of the paper, while adding only modestly to the qualitative insights obtained.

[7] The reason for this aversion to divergent belief models is simply that they do not explain the source of the divergence.

[8] Although unstated, the underlying rationale here is presumably that a manufacturer with a good for which there is high demand will always want to offer a returns policy. First, it induces the retailer to carry more stock and second it has low cost since no returns actually occur if demand is high.

[9] Risk neutrality ensures that our results do not rest on the insurance benefits stemming from a returns policy.

[10] It should be thought of as a perishable or fad good.

[11] This assumes that the unconditional demands satisfy $a_i - \beta p \geq 0$. Since we show later that in equilibrium $a_\ell - \beta p^* < 0$, strictly speaking $D(p\,|\,q) \equiv \lambda \max\{\min\{a_h - \beta p, q\}, 0\} + (1-\lambda)\max\{\min\{a_\ell - \beta p, q\}, 0\}$.

[12] We assume that the retailer chooses stock q_1 if indifferent between q_1 and zero.

[13] Our model differs from Kandel in that we assume that demand is downward sloping, rather than perfectly elastic, and that the demand uncertainty is discrete (demand is either high or low) rather than continuous. Kandel briefly considers the case of downward sloping demand, but notes that closed-form solutions for the refund are not obtainable. He also allows for the refund to be higher than the wholesale price, and in fact shows the equilibrium to have this property. We would get the same result if we relaxed Assumption 1 since our result is a corner solution.

[14] They assert that the model structure that we analyze is not tractable.

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