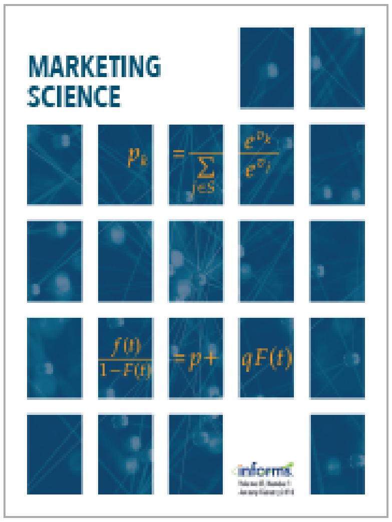

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Commentary

On "Equilibrium Returns Policies in the Presence of Supplier Competition"

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The recent article by Bandyopadhyay and Paul [Bandyopadhyay S, Paul AA (2010) Equilibrium returns policies in the presence of supplier competition. *Marketing Sci.* 29(5):846–857] searched for an explanation for the phenomenon the authors termed the "Pasternack paradox," i.e., why full-credit return policies, which were considered suboptimal from the perspective of channel coordination, are prevalent in practice. The authors argued that the underlying reason is that it is the competition between suppliers rather than the coordination among channel members that dominates business practice. We show that their model actually fails to generate the claimed results. Counterexamples are given. Alternative explanations are therefore needed for the seemingly suboptimal business practice.

Key words: returns policy; channel competition; channel coordination
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1. Introduction

In his seminal work, Pasternack (1985) showed that in supply chains of perishable goods with a supplier and a retailer (or multiple retailers), the supplier can coordinate the channel by allowing unlimited returns from the retailer and offering a partial credit for each returned unit. Despite the theoretical appeal of partial-credit return policies, Bandyopadhyay and Paul (2010) (BP hereafter) found from their survey of practitioners that in a wide range of industries, such as newspapers and magazines, perishable processed foods, and fashion cosmetics, it is full-credit return policies that are widely adopted.

Motivated by the persistent prevalence of this seemingly suboptimal practice, BP went on to provide an explanation. They argued that business practice is actually driven by the competition between suppliers rather than the coordination among channel members, and it is the competition between suppliers that leads to the prevalence of full-credit return policies.

Although their idea is plausible, BP's model actually fails to generate the claimed results. After pointing out the flaw in their proof, we provide counterexamples to demonstrate that within their model setting, full-credit return policies can never be the equilibrium choice for suppliers. Different interpretations are therefore needed to explain this seemingly suboptimal business practice.

2. The Issues with the BP Model

To put the discussion in perspective, we briefly describe the BP model as follows. Two suppliers compete to sell a single product to a retailer, whose demand, D, is uncertain. First, each supplier offers the retailer a buyback contract, characterized by a wholesale price w_i and a return price c_i, $i = 1, 2$. The retailer then decides on the quantity to order from each supplier. The two suppliers are assumed to have limited capacities, k_1 and k_2, respectively, such that $k_1 + k_2$ is larger than the minimum possible retail demand; this is to eliminate the trivial case that suppliers might never receive returns from the retailer. The suppliers' production costs are normalized to be 0, and the retail price p is fixed. Facing the contracts offered by the suppliers, the retailer sources optimally to maximize its profit, and the two suppliers anticipate the reaction of the retailer and maximize their own profits by setting proper contract parameters. Proposition 1 in BP made the following claim:

> A full-credit returns policy is the unique mixed-strategy Nash equilibrium of the game when there are two or more suppliers. There is no pure-strategy equilibrium. Specifically, either manufacturer would choose a wholesale price between the retail price p and 0 (or the higher of the marginal costs with asymmetric suppliers) randomly and offer a full credit for every unsold unit of the product. The results hold true even with asymmetric suppliers.
>
> (Bandyopadhyay and Paul 2010, p. 852)

Their proof of Proposition 1, however, is problematic. We point out the critical flaw in their proof in the appendix. More importantly, Proposition 1 itself seems also problematic. We make the following observation.

Claim 1. *If Proposition* 1 *were true, the suppliers' profits would be zero.*

It is well known that in a mixed-strategy equilibrium, all pure strategies drawn from a player's equilibrium mixed strategy should yield the same payoff. If one supplier chooses a wholesale price 0 (or nearly 0), the expected profit would obviously be 0 (or nearly 0), independently of the other player's strategy. As a result, if Proposition 1 were true, i.e., if the suppliers choose a wholesale price between 0 and p randomly, the profit of the suppliers would always be zero. Therefore, a mixed strategy as described in Proposition 1 is really not meaningful.

The above analysis might seem very extreme, because we allow suppliers to charge a zero wholesale price. One might wonder whether it was possible that in equilibrium, the wholesale price of the suppliers could be actually randomly chosen from a segment away from 0. The following claim, however, shows that this is not possible either.

Claim 2. *In the BP model, it is generally not possible to have full-credit return policies as a mixed-strategy equilibrium, even if the wholesale price w_i is randomly selected from an interval $[a_i, b_i]$ such that $0 < a_i < b_i \le p$.*

We illustrate this through a nontrivial example. Let the demand of the retailer be uniformly distributed; $D \sim \mathrm{U}(200, 600)$. The suppliers have limited production capacity, $k_1 = 300$ and $k_2 = 200$. The suppliers' production cost is 0. This is a typical setting for the BP model. We will show that for supplier i, any full-credit return policy is strictly dominated by some partial-credit return policy.

First, note that if supplier i is the only supplier, the retailer faces the classical newsvendor setting and will order an amount Q_i^* such that $F(D \le Q_i^*) = (p - w_i)/(p - c_i)$. Next, note that the total capacity of the suppliers, $k_1 + k_2 = 500$, is equal to the 75th percentile of the retailer's demand distribution. As a result, if only supplier i sets its policy such that $3/4 \le (p - w_i)/(p - c_i) \le 1$, that supplier will always receive an order of size $Q_i = k_i$ from the retailer, no matter what strategy is adopted by the competing supplier (the capacity of the competing supplier, in any case, is insufficient, and the retailer is always better off ordering from supplier i). Now assume supplier i adopts a full-credit return policy (w_i, c_i) such that $w_i = c_i = w$. The order that supplier i receives from the retailer must be $Q_i = k_i$. Such a policy, however, is strictly dominated by a partial-credit return policy (w_i', c_i') such that $w_i' = w$ and $(p - w_i')/(p - c_i') = 3/4$. With the new policy, supplier i receives the same revenue but will incur a lower cost of returns. Therefore, as this example shows, full-credit return policies cannot be an equilibrium for typical BP settings.

Claim 3. *If the production cost in the BP model is relaxed to be positive, in general, full-credit return policies cannot be the equilibrium either.*

With full-credit return policies from suppliers, the retailer has no reason not to order up to the maximum possible value of the demand. Consider the case that the maximum possible value of the demand is larger than the total capacity of the suppliers. The retailer will order up to the total capacity of the two suppliers. As a result, the suppliers are very likely to receive a large amount of returns. Because of the positive production cost, the profits of the suppliers could easily go negative. For such cases, there is no reason for suppliers to adopt full-credit return policies.

3. Summary

The survey by BP revealed that full-credit return policies are a very common business practice. This is somehow surprising, because the classical theory on return policies (Pasternack 1985) says that full-credit return policies cannot achieve channel coordination. BP provided an explanation for why this seemingly inferior practice is so prevalent. Although we tend to agree with their idea, their model failed to deliver the claimed results. Moreover, BP's model is perhaps hard to fix. To us, BP's motivation for selecting the setting of their model is puzzling. In our observations, although a retailer may face many different suppliers, these suppliers do not sell the same product. Therefore, a different explanation is needed for the "Pasternack paradox."

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Appendix

The proof of Proposition 1 in BP is problematic. The strategy of their proof was (1) to show that there exists a mixed-strategy equilibrium and (2) to show that there does not exist an equilibrium partial-credit return policy; as a result, the mixed-strategy equilibrium must be a full-credit return policy. Note that the strategy space of each player is a triangular region of the $w-c$ plane bounded by the lines $w \leq c$, $c = 0$, and $w = p$. As one step to establish (2), BP tried to show that the equilibrium mixed-strategy cannot be drawn from the interior of the feasible region. Here is a brief summary of this step. Assume the strategy of supplier 1 is to draw (w, c) randomly on a curve according to a distribution. Consider the expected profit $\Pi(t)$ of supplier 2 when it draws a point t in the $w-c$ plane. If supplier 2's best response to supplier 1's strategy is to draw (w, c) randomly on a curve T according to a distribution H, it follows that $\Pi(t_1) = \Pi(t_2)\ \forall\, t_1 \in T,\ t_2 \in T$ and $\Pi(t_1) < \Pi(t_2)\ \forall\, t_1 \notin T,\ t_2 \in T$. Let the value of $\Pi(t)$ at every point $t \in T$ be Π_0. For a given $\epsilon > 0$, define $V = \{(w, c)\colon \Pi(t) = \Pi_0 - \epsilon\}$. For a sufficiently small ϵ, V is a simple closed curve that encloses T. Therefore, there are two points v_1 and v_2 on V such that the straight line joining them intersects T at a point, denoted v_0. Since v_0 is a convex combination of v_1 and v_2, BP claimed the expected profit from playing the strategy v_0 is equal to $E[qz_1 + (1-q)z_2] = \Pi_0 - \epsilon$, where z_1 and z_2 are the profits from playing v_1 and v_2, respectively. Such a claim, however, is wrong. The profit of supplier 2 is not a linear function of w and c, and in general, playing a strategy obtained from a linear combination of strategies v_1 and v_2 will not give a profit equal to the same linear combination of the profits obtained from playing v_1 and v_2. This equality, unfortunately, is critical to the proof of BP, because they went on to establish a contradiction based on it: v_0 was supposed to give a profit equal to Π_0 since it belongs to T, which contradicts the claim that $\Pi(v_0) = \Pi_0 - \epsilon$. The failure to establish this contradiction leads to the failure of the proof.

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