

Review Article

Managing Cost Reduction Efforts in Supplier Encroachment

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Received 17 December 2020; Revised 11 January 2021; Accepted 16 January 2021; Published 9 February 2021

Academic Editor: Kin Keung Lai

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The extant literature has indicated that upstream supplier encroachment on the incumbent retailer could be beneficial to the supplier, the retailer, and the entire industry, when the supplier's marketing disadvantage satisfies specific conditions. This study extends the previous investigations about supplier encroachment to the circumstance where the supplier is capable of managing and mitigating her marketing disadvantage, which further intensifies the retail competition and provides new managerial implications about the encroachment. We find that encroachment with cost reduction efforts does not necessarily hurt the retailer and the industry but always benefit the supplier and consumers. Compared to encroachment without the cost reduction effort, encroachment with cost reduction efforts does not necessarily benefit the supplier and the industry. Between encroachment with and without cost reduction efforts, the retailer and consumers always prefer the latter and the former, respectively. Our findings provide meaningful insights to manage cost reduction efforts in supply chain encroachment.

1. Introduction

Benefited from the recent development of e-commerce and express delivery service, encroachment is now playing a vital role in increasing supplier profit. Encroachment occurs when the upstream supplier in a supply chain sells the product directly to consumers and thereby competes with her retailers by opening company-owned franchises, catalog sales, online stores, and factory outlets. Opening direct channels usually involves supplier's significant investments in establishing the direct channel and adopting retail practice [1]. Supplier encroachment is in a sense a representation of channel decentralization [2–5].

As mentioned in previous studies [1, 6–9], the supplier suffers a marketing disadvantage in the sales and marketing process. The marketing disadvantage is usually stemmed from the fact that the retailer has superior knowledge of customer preferences, more direct contact with customers, or economies of scope with other retailing activities, such as merchandising and promoting planning, while the supplier incurs a higher selling cost due to inexperience, inefficiency in retailing operations, or the extra

cost of opening e-commerce. The significance of this marketing advantage has been extensively investigated and well understood in the existing literature, which significantly affect the firms' decisions and profits as a key performance driver.

In real life, many suppliers should reasonably make efforts to mitigate their marketing disadvantage resulted from the encroachment [10, 11]. To the best of our knowledge, the role of cost reduction efforts in encroachment has never been explored in the literature. The primary purpose of this study is to fill this gap by addressing the following research questions:

- (1) How would encroachment with cost reduction efforts affect the profits of supplier, retailer, and entire industry?
- (2) How would an encroaching supplier choose to make cost reduction efforts or not?

Our model extends the study by Arya et al. [6] by allowing the supplier to make efforts to mitigate her marketing disadvantage, in terms of reducing her selling cost. The efforts function is in a quadratic form, and the supplier

has the flexibility of determining any cost reduction level. Our findings are summarized as follows:

- (1) Encroachment with cost reduction efforts always benefit the supplier and consumers, benefits the retailer when the marketing disadvantage is extremely large, and the industry when the marketing disadvantage is either sufficiently small or extremely large
- (2) In the encroachment circumstance, cost reduction efforts do not necessarily benefit the encroaching supplier and is harmful/beneficial to the retailer/consumers
- (3) Pareto zones can arise from the encroachment, in which all players may benefit from encroachment without or with cost reduction efforts

The main contributions of this study are summarized as follows. First, we investigate the supplier encroachment with the consideration of upstream supplier's marketing disadvantage. Previous encroachment literature has almost ignored this issue. Second, we explore the encroachment without and with cost reduction efforts scenarios and compare them with no-encroachment setting for analysis. Third, cost reduction efforts have been optimized in this study, along with managerial implications and insights.

The rest of this study proceeds as follows. Section 2 describes the key elements of the model. Section 3 gives the results for analysis. Section 4 provides our central analysis. Section 5 concludes this study and offers possible future research directions.

2. Model Setup

Consider a vertical supply chain consisting of an upstream supplier (she) selling a wholesale product to a downstream retailer (he), who in turn sells it to the final consumers engaging in Cournot competition. Meanwhile, the supplier has the option to sell the product to consumers by operating her own direct channel, taking the forms of company-owned franchises, catalog sales, online stores, and factory outlets [6]. For exposition ease, we assume that the supplier produces only a category of the product for sale and the market size is sufficiently large to facilitate our analysis. The price of the product is determined by a linear, downward sloping, inverse demand function $p(q) = a - q$, where a is the maximum market demand, and q is the total amount of product available in the market [6–8]. Without the loss of generality, we also assume that the unit production cost is zero. Then, the occurrence of a negative wholesale price charged by the supplier to the retailer represents that the wholesale price is lower than the actual production cost. To simplify the illustration of our analysis, the per unit selling costs of the supplier and the retailer are scaled to c , $c \in [0, a)$ and zero, respectively.

The above setting is nearly identical to that of Arya et al. [6]. However, to mitigate her marketing disadvantage, the supplier can take effort to reduce her unit selling cost by x

with a unit cost of effort $(kx^2/2)$ [12]. A larger k means a higher cost of effort for the supplier to reduce her reselling cost. This form of cost function implies that the supplier can determine any effort level and captures the diminishing return of effort [1, 12–14].

The timeline of our model in this study is as follows. First, the supplier determines her unit wholesale price (w). Second, the retailer establishes his profit-maximizing retail quantity (q_r). Third, the supplier simultaneously decides on the quantity (q_s) that he sells directly and the cost reduction effort (x) to mitigate her marketing disadvantage. Backward induction will be employed to obtain the equilibrium of this three-stage game. This event sequence entails three models to investigate no-encroachment (N), encroachment without cost reduction effort (E), and encroachment with cost reduction effort (EE). The first two models have been previously studied by Arya et al. [6], which would be reviewed in the next section for comparison purpose.

3. Results

3.1. No-Encroachment Setting. We begin with investigating the no-encroachment setting in which the supplier sells the product exclusively through her retailer. Given the wholesale price w , the retailer establishes the order quantity (q_r) to maximize his monopoly profit by solving

$$\max_{q_r} \{(a - q_r - w)q_r\}, \quad (1)$$

from which it yields

$$q_r^N = \frac{a - w}{2}. \quad (2)$$

Anticipating the retailer's response to the wholesale price, the supplier decides on w to maximize her profit through solving

$$\max_w \{wq_r^N\} = \max_w \left\{ \frac{w(a - w)}{2} \right\}, \quad (3)$$

this equation yields

$$w^N = \frac{a}{2}, \quad (4)$$

and hence,

$$q_r^N = \frac{a}{4}. \quad (5)$$

After substituting the wholesale price (4) and order quantity (5) into the retailer's profit (1) and the supplier's profit (3), we obtain

$$\pi_r^N = \frac{a^2}{16}, \quad (6)$$

$$\pi_s^N = \frac{a^2}{8}.$$

Consumer surplus in no-encroachment setting CS^N is

$$CS^N = \int_0^{q_r^N} (q_r^N - q) dq = \frac{(q_r^N)^2}{2} = \frac{a^2}{32}. \quad (7)$$

3.2. Encroachment without Cost Reduction Efforts Setting. We next examine the encroachment without cost reduction efforts setting, in which the supplier takes an effort to mitigate her marketing disadvantage. Following the aforementioned timeline, the supplier establishes the selling quantity through her direct channel (q_s), taking the wholesale price w and the retailer's order quantity (q_r) as given. The supplier's problem is

$$\max_{q_s} \{(a - q_r - q_s - c)q_s + wq_r\}, \quad (8)$$

which generates her best response quantity as

$$q_s^E = \frac{a - c - q_r}{2}. \quad (9)$$

Given the wholesale price w and anticipating the supplier's response q_s^E , the retailer chooses the order quantity q_r by maximizing his own profit:

$$\max_{q_r} \{(a - q_r - q_s^E - w)q_r\}, \quad (10)$$

this expression yields

$$q_r^E = \frac{a - c + 2w}{2}, \quad (11)$$

and then, this expression yields

$$q_s^E = \frac{a - c + 2w}{4}. \quad (12)$$

Substituting q_r^E in (11) and q_s^E in (12) into the supplier's profit in (8) gives rise to

$$w^E = \frac{3a - c}{6}, \quad (13)$$

and hence,

$$q_r^E = \frac{2c}{3}, \quad (14)$$

$$q_s^E = \frac{3a - 5c}{6}.$$

After substituting the wholesale price w^E in (13) and retail quantities q_r^E and q_s^E in (14) into the supplier's profit in (8) and the retailer's profit in (10), we derive

$$\pi_s^E = \frac{3a^2 - 6ac + 7c^2}{12}, \quad (15)$$

$$\pi_r^E = \frac{2c^2}{9}.$$

Consumer surplus in encroachment without cost reduction efforts setting CS^E is

$$CS^E = \frac{(q_s^E + q_r^E)^2}{2} = \frac{(3a - c)^2}{72}. \quad (16)$$

3.3. Encroachment with Cost Reduction Efforts Setting. We finally investigate the encroachment with the cost reduction efforts setting, in which the supplier takes the cost reduction effort to mitigate her marketing disadvantage due to the fact that the selling cost often acts as a vital dimension of competitive edge. Consistent with outlined timing, the supplier simultaneously determines her direct sale quantity q_s and cost reduction effort x given the wholesale price w , and the retailer's order quantity (q_r),

$$\max_{\{q_s, x\}} \left\{ \left[a - q_r - q_s - (c - x) - \frac{kx^2}{2} \right] q_s + wq_r \right\}, \quad (17)$$

and obtain

$$q_s^{EE} = \frac{1 + 2k(a - c - q_r)}{4k}, \quad (18)$$

$$x = \frac{1}{k}.$$

Anticipating these, the retailer chooses his order quantity q_r^{EE} by maximizing his profit:

$$\max_{q_r} \{(a - q_r - q_s^{EE} - w)q_r\}, \quad (19)$$

which yields

$$q_r^{EE} = \frac{-1 + 2k(a + c - 2w)}{4k}. \quad (20)$$

Substituting q_r^{EE} in (20) into q_s^{EE} in (18) and then substituting them into the supplier's profit in (17), the supplier's profit is a function with respect to w only:

$$\max_w \left\{ \left[a - q_r^{EE} - q_s^{EE} - (c - x) - \frac{kx^2}{2} \right] q_s^{EE} + wq_r^{EE} \right\}. \quad (21)$$

Solving this optimization problem, we obtain the supplier's optimal wholesale price w^{EE} as

$$w^{EE} = \frac{1 + 6ka - 2kc}{12k}. \quad (22)$$

Substituting w^{EE} into q_r^{EE} in (20) into q_s^{EE} in (18) yields the following solutions:

$$q_r^{EE} = \frac{2kc - 1}{3k}, \quad (23)$$

$$q_s^{EE} = \frac{5 + 6ka - 10kc}{12k}.$$

Now, the expressions are ready to compute the supplier's profit and the retailer's profit as follows:

$$\pi_s^{EE} = \frac{12k^2 a^2 + 12ka(1-2kc) + 7(1-2kc)^2}{48k^2}, \quad (24)$$

$$\pi_r^{EE} = \frac{(1-2kc)^2}{18k^2}.$$

Consumer surplus in encroachment with cost reduction efforts setting CS^{EE} is

$$CS^{EE} = \frac{(q_s^{EE} + q_r^{EE})^2}{2} = \frac{[1 + 2k(3a - c)]^2}{288k^2}. \quad (25)$$

4. Analysis

Because Arya et al. [6] have performed an exhaustive analysis between no-encroachment and encroachment without cost reduction efforts, we emphasize the role of cost reduction efforts playing in supplier encroachment in this section.

4.1. No-Encroachment vs. Encroachment with Cost Reduction Efforts. As an alternative choice for the supplier, her ability to sell directly to consumers would definitely intensify the retail competition. Confronted with the marketing disadvantage in her direct sale, the supplier may make efforts to reduce her additional selling cost compared to the traditional retail. This motivates the following comparisons between no-encroachment and encroachment with cost reduction efforts settings.

Proposition 1. *The supplier encroaches on the incumbent retailer with cost reduction efforts if and only if $(1/2k) < c < (5 + 6ka/10k)$. The supplier and consumers always benefit from encroachment.*

Proposition 1 confirms the findings in the case of encroachment without cost reduction efforts setting [6], which indicates that the supplier will encroach if and only if her marketing disadvantage is not very significant. By doing this, the supplier earns more profits and the consumer surplus is larger.

Similar to the previous studies [6, 15] demonstrating the direct sale may not always be harmful to the retailer because of the wholesale price effect, we are also interested in seeing what happens in the presence of the supplier encroachment with cost reduction efforts.

Lemma 1. *Encroachment with cost reduction efforts will motivate the supplier to reduce her wholesale price as $w^E - w^N = (1 - 2kc/12k) < 0$.*

Lemma 1 shows that the supplier alleviates the retail competition through reducing her wholesale price to boost demand at the end of the retailer and thereby expand the sufficient use of this sales channel. Because the mentioned wholesale price effect is positively proportional to her marketing disadvantage (c), then lower wholesale price implies that the retailer could benefit from the supplier encroachment.

Proposition 2. *Encroachment with cost reduction efforts benefits the retailer if and only if $(4 + 3\sqrt{2}ka/8k) < c < (5 + 6ka/10k)$.*

Proposition 2 verifies the previous results that the addition of direct sales is not necessarily detrimental to the incumbent retailer. In the case that the supplier's marketing disadvantage is sufficiently large, the significant wholesale price reduction dominates the demand loss due to the retail competition, and therefore, the retailer benefits from the supplier encroachment. However, when the retailer's marketing advantage is small, i.e., $(1/2k) < c < (4 + 3\sqrt{2}ka/8k)$, supplier encroachment would hurt the incumbent retailer.

Propositions 1 and 2 jointly yield a Pareto zone: $(4 + 3\sqrt{2}ka/8k) < c < (5 + 6ka/10k)$, in which both the supplier and the retailer may benefit from the competition arisen from supplier encroachment with cost reduction efforts to mitigate her marketing disadvantage.

We are also interested in the impact of encroachment with cost reduction efforts on whole industry profit because of the fact that both the supplier and the retailer may benefit from such an encroachment.

Proposition 3. *Encroachment with cost reduction efforts benefits the industry if and only if $(1/2k) < c < (29 + (18 - 3\sqrt{7})ka/58)$ or $(29 + (18 + 3\sqrt{7})ka/58) < c < (5 + 6ka/10)$.*

Proposition 3 reflects that encroachment with cost reduction efforts will increase entire industry profit when the supplier's marketing disadvantage is either sufficiently small ($(1/2k) < c < (29 + (18 - 3\sqrt{7})ka/58)$) or extremely large ($(29 + (18 + 3\sqrt{7})ka/58) < c < (5 + 6ka/10)$). More specifically, when the supplier's marketing disadvantage is sufficiently small, she is capable of efficiently managing her direct sales and avoiding the double marginalization problem; when the supplier's marketing disadvantage is extremely large, the wholesale price effect dominates the retail competition and thereby effectively reduces losses from double marginalization.

4.2. Encroachment without vs. with Cost Reduction Efforts. In this section, we investigate the effectiveness of supplier's cost reduction efforts by comparing two encroachment forms: without and with cost reduction efforts. To facilitate our analysis, we compare the wholesale prices in three models and assume $0 < k < (6a - 5/6a)$.

Lemma 2. *The sequence of wholesale prices in three models are $w^E < w^{EE} < w^N$, and $\Delta w = w^{EE} - w^E = (1/12k)$.*

Lemma 2 observes that in the presence of cost reduction efforts, the supplier encroaches by establishing a higher wholesale price than that in the absence of cost reduction efforts, the gap between which is solely related to the supplier's unit cost of efforts.

Because cost reduction efforts can alleviate the supplier's marketing disadvantage, one would expect cost reduction efforts to increase her profit and reduce the retailer's profit. The following proposition characterizes the performance of supplier, retailer, and consumers.

Proposition 4. *The supplier prefers encroachment with cost reduction efforts when $(1/2k) < c < (7 + 12ka/28)$ and without cost reduction efforts when $(7 + 12ka/28) < c < (5 + 6ka/10)$, while the retailer always prefers encroachment without cost reduction efforts, and the consumers conversely prefers encroachment with cost reduction efforts.*

The conventional wisdom suggests that reduced cost accompanies encroachment will benefit the supplier. Proposition 4 contradicts this and observes that the supplier's cost reduction efforts do not necessarily yield more profit. Although encroachment with cost reduction efforts reduces the supplier's unit selling cost with $\Delta c = x - (kx^2/2) = (1/2k) > 0$, she will obtain more profit when her selling cost does not exceed a threshold, i.e., $(1/2k) < c < (7 + 12ka/28)$. This is because encroachment with cost reduction efforts induces the supplier to increase the wholesale price in the retailer and reduce the selling cost in her own channel, at the expense of extracting a portion of demand. When the marketing advantage is sufficiently large, the reduced revenue cannot cover the reduced cost and increased wholesale price effects, and thereby, encroachment without cost reduction efforts outperforms that with and without cost reduction efforts.

Analogously, there exists the other Pareto zone, i.e., $(1/2k) < c < (7 + 12ka/28)$, in which both the supplier and the retailer benefit from encroachment with cost reduction efforts.

Once again, encroachment with cost reduction efforts can increase industry profit even when it is less preferable by the retailer. This finding is in line with Proposition 3.

Proposition 5. *The industry prefers encroachment with cost reduction efforts when $(1/2k) < c < (29 + 36ka/116)$ and without cost reduction efforts when $(29 + 36ka/116) < c < (5 + 6ka/10)$.*

Proposition 5 claims that the supplier encroachment with and without cost reduction efforts may benefit the whole industry. This originated from the observations that the supplier and retailer have different preferences about the encroachment with and without cost reduction efforts.

5. Conclusion

The present study extends the study by Arya et al. [6] by investigating the case that the supplier may make efforts to manage her marketing disadvantage, alternatively denoted as an additional selling cost, which is a key performance driver in encroachment. We observe that the encroachment with cost reduction efforts affects the players' decisions and profits following the same manner of the encroachment without cost reduction efforts. To study the impact of cost reduction efforts, we compare the performance between these two encroachment forms and surprisingly find that supplier's cost reduction efforts do not necessarily yield more profit and is harmful to the retailer and beneficial to the consumers.

Future research could consider different function forms of the supplier's efforts to manage the selling cost and study the impact of retail service, advertising decisions in encroachment. In addition, future research should consider managing the cost reduction efforts in supplier encroachment in the mixed market [16], under different power structure [17], and with the collusion [18].

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors would like to thank the anonymous review team for helpful comments on earlier drafts of this paper. This research was financially supported by Project of Guangdong Planning Office of Philosophy and Social Science (No. GD18CGL06), Project of Shenzhen Planning Office of Philosophy and Social Science (No. SZ2018C012), and Project of Shenzhen Polytechnic (No. 601722S22013).

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