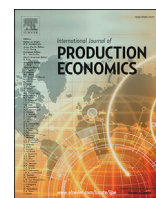


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Timing of sales commitment in a supply chain with manufacturer-quality and retailer-effort induced demand

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ABSTRACT

A manufacturer can costly invest in new technology to enhance the product quality and a retailer can enroll more sales forces to improve the sales effort level. Although both activities can effectively increase the market demand, the outcome from quality enhancement is generally uncertain and influenced by some random factors. This paper investigates the timing effect of retailer's commitment of sales effort on the firms' equilibrium investment and pricing decisions in a decentralized supply chain. We consider two different scenarios: early commitment and delay commitment, depending on whether the retailer's commitment of sales effort is before or after the manufacturer's enhanced quality level is resolved. It shows that under the delay commitment scenario, both the manufacturer's and the retailer's investment levels become higher than that under the early commitment scenario. This subsequently leads to higher payoffs for the retailer and the supply chain under the delay commitment scenario. However, from the manufacturer's perspective, either timing scenario could be the dominant option, which is dependent on the magnitude of quality enhancement variability. Interestingly, the manufacturer prefers delay commitment when the quality enhancement variability is sufficiently high, which implies that he may voluntarily prefer to personally endure the entire quality risk when its level gets higher.

1. Introduction

In a distribution channel where a manufacturer (he) delegates the sales responsibility to an independent retailer (she), both firms can exert certain efforts to improve the supply chain's performance and efficiency. On the one hand, the manufacturer can invest in new technology or strengthen the production control process to enhance the product quality and attract more consumers. On the other hand, the retailer is able to enroll more sales forces or to design a more targeted marketing campaign to stimulate the consumption. Both activities are viewed as two important demand-enhancing strategies: the manufacturer's quality enhancement and the retailer's sales effort investment, which have been widely adopted in the practice and investigated by different scholars (Gurnani et al., 2007; Gurnani and Erkoc, 2008; Ma et al., 2013b).

Nonetheless, in practice, although a manufacturer can target a quality level to enhance, the actual outcome of such an enhancement process is typically unreliable as it can be influenced by many random factors (e.g., technical failures and the change of consumer preference). Consider an

example in the movie industry. In 2014, Wanda film company (www.wandafilm.com) has already announced the distribution information (including its release time and screen numbers) for its invested movie of "The Ghoul", a year before its official release date.¹ A film company may invest heavily in new technologies (e.g., 3D technology and IMAX) or create an all-star cast to improve the movie's quality. However, it cannot guarantee a high quality for the movie, as a movie's quality is inevitably influenced by many random factors, such as the director's personal style and the consumers' tastes. This is also quite prevalent in the new product development process, in particular for the categories with shorter product lifespan and consumer uncertainty about quality, such as the fast consumer goods, mobile, fashion, and electronics (Guo, 2009; Guan and Chen, 2016). In all these categories, the quality enhancement is generally hard to control and varies significantly according to the consumer preferences.

Given this potential risk from quality enhancement, this paper investigates the pivotal timing effect of retailer's commitment about her sales effort level for the product. Notably, this timing of retailer's sales

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commitment can directly determine the allocation of quality investment risk between the manufacturer and the retailer, which consequently influences their equilibrium strategies (quality enhancement, sales effort, and pricing) and payoffs. For example, a retailer may prefer to first observe the resolved quality level from the manufacturer and then decides in what effort extent to sell the product. Under this circumstance, the retailer would not carry any risk from an uncertain outcome of manufacturer's quality enhancement process. However, from the manufacturer's perspective, it might be in his interest to first receive a commitment of sales effort level from the retailer before making his quality enhancement decision. Because by doing so, the manufacturer partially transfers the quality risk to the retailer's side. When the resolved quality level is very low, the manufacturer can at least receive a comparatively high sales effort from the retailer to extract more surplus from the market.

The diversity of decision is also prevalent in the practise. For example, Vipshop (www.vip.com) as a leading online shop company and a fashion online shopping platform in China, resells thousands of products from those high end and middle-class brands to the consumers at relatively low prices. Accordingly to the survey, its market value has reached around ten billion dollars in 2016.² Because a consumer's tastes may change very fast over the time, Vipshop would dynamically monitor every brand's performance/revenue from its web-site and accordingly assign its sales resources to different brands. These sales resources include the sales links/pages, customized financing option, and strong after-sales service support, and Vipshop normally assigns more resources to those brands with better performances. However, such a policy never applies to those dominant brands in the industry, such as Gucci and Prada. Instead, Vipshop needs to first commit a certain sales promotion level to these brands, regardless of how their actual performances would be in the practice.

Motivated by above discussion, in this paper, we will consider two representative decision sequences with respect to the timing of retailer's sales effort commitment. In the first—the **early commitment format**—the retailer ex-ante commits a sales effort level to the manufacturer before the manufacturer determining his targeted level of quality enhancement. In the second—the **delay commitment format**—the retailer ex-post decides the sales effort level after observing the exact product quality. We are interested in the following research questions that have not been adequately investigated before.

- First, how do the manufacturer and the retailer choose the levels of quality enhancement and sales effort under different formats?
- Second, how does the timing of retailer's commitment influence the manufacturer's, the retailer's and the supply chain's payoffs?
- Third, how do the quality variability, the cost of quality enhancement and the cost of sales effort influence the firms' equilibrium strategies and payoffs under different formats?

To answer these questions, we construct a standard two-echelon supply chain wherein the manufacturer (he) sells his products to a retailer and the retailer distributes these products to the end consumers. The manufacturer decides the wholesale price for each unit of his product and the retailer according to sets the retail price. Before making the pricing decisions, both the manufacturer and the retailer can costly exert efforts on quality enhancement and sales effort to increase the potential market demand, respectively. Notably, we assume that the product quality is initially uncertain so that the exact quality level finally achieved is a random outcome from quality enhancement. Building upon this, it naturally generates two different decision timing scenarios—early commitment scenario and delay commitment scenario, depending on whether the retailer's commitment of sales effort is before

or after the uncertain quality is resolved.

Our analysis identifies several interesting observations that speak to the strategic interactions between the manufacturer and the retailer. First, we show that under the delay commitment scenario, both firms will invest more than that under the early commitment scenario. The intuition is that under the early commitment scenario, in equilibrium the retailer would only commit a low investment on the sales effort level to avoid the negative consequence that the resolved quality level is very low. This limited sales effort level further reduces the manufacturer's incentive of enhancing the product quality, so that both firms become conservative at investment under this scenario. In contrast, under the delay commitment scenario, the retailer's sales effort is entirely determined by the resolved quality level. Therefore, the manufacturer has no choice but to invest more in the quality enhancement so as to incentivize the retailer to invest more in the sales effort, even though he has to endure more risk from quality uncertainty. Thus, both firms become more active at their investments under this commitment format.

Second, building upon the firms' equilibrium investment decisions, we show that the retailer's payoff is always higher under the delay commitment scenario while the manufacturer's payoff is higher under the early commitment scenario only if the magnitude of quality variance is relatively low. In other words, when the magnitude of quality variance is high, the manufacturer may benefit from suffering more risk from quality uncertainty than transferring it to the retailer. This is an unintended result, which is driven by the two conflicting effects from the timing of retailer's commitment. Making an early sales commitment ensures the manufacturer not to entirely suffer the losses when the resolved quality is low, while it also prevents the retailer's incentive at investing the sales effort which could create more harm to the manufacturer once the magnitude of quality variance is very high.

Third, we also draw some implications when the manufacturer can partially afford the retailer's investment in the sales effort. This may represent the practice that the manufacturer can directly spend on advertising or labeling to introduce his products. Under the delay commitment scenario, we show that this cost-sharing mechanism can conditionally improve both firms' payoffs, in which the Pareto improvement zone exists only if the cost sharing percentage falls into an intermediate range. Besides, we investigate several possible variations of decision timing in our game setting, which have also been discussed by prior literature (e.g., Gurnani et al., 2007). Although the firms' equilibrium strategies and payoffs may change under different scenarios, none of these scenarios could become the firm's prior option comparing to the early commitment scenario or the delay commitment scenario.

The remainder of this article is organized as follows. We summarize the related literature in Section 2. In Section 3, we lay out the model setup. The analysis of equilibrium acquisition strategies is presented in Section 4. Section 5 discusses some extensions. Section 6 concludes the article. Proofs are shown in the Appendix.

2. Literature review

Our paper belongs to the vast literature that investigates the impacts of manufacturer's quality enhancement (Banker et al., 1998; Singer et al., 2003; De Giovanni, 2011; Matsubayashi, 2007; Lee et al., 2013; Xie et al., 2011; Chen et al., 2015) and retailer's sales effort (Wei and Chen, 2011; Dan et al., 2012; Li and Liu, 2015; Yan and Zaric, 2016) on the demand sensitive supply chain. For example, Gurnani and Xu (2006) study the vertical price competition and sales effort competition between a manufacturer and a retailer. Yu and Ma (2013) study the decision sequence of pricing and quality investment between two suppliers, and find that the suppliers' payoffs depending highly on the cost structure. Wang et al. (2013) compare four scenarios with different timings of sales effort investment and find that the dominant retailer always prefers the ex-post effort decision. Pal et al. (2015) investigate the supply chain's performance under six model structures with different decisions sequences and explore how the warranty policy can motivate the firms to

² For more information, please refer to the source at <http://www.chinavalue.net/Story/2017-2-22/754931.html>.

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