



Hierarchical quality disclosure in a supply chain with cost heterogeneity



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ABSTRACT

This paper investigates a two-layer information disclosure model in the supply chain, wherein a manufacturer privately observes his product quality and delegates the sales responsibility to an independent retailer who possesses the pricing power. In the presence of information asymmetry, either the manufacturer or the retailer can determine whether to costly disclose the product quality information to the consumer. We show that in equilibrium both firms strategically select their disclosure options according to the disclosure costs and the ex-post quality level, thereby leading to some unintended phenomena. The retail price, the retailer's and the supply chain's payoffs may increase simultaneously when the product quality goes down. The decentralized supply chain can generate a higher ex-post payoff than the integrated supply chain once the product quality is sufficiently low. We also examine the impact of disclosure costs on the supply chain's ex-ante payoff, and find that it is more beneficial for a single firm to afford the entire disclosure costs in the channel. Moreover, with revenue sharing contract this allocation of disclosure costs can give rise to a higher supply chain's payoff than that in the integrated supply chain.

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1. Introduction

When a manufacturer delegates the sales responsibility to an independent retailer, he needs to consider how to introduce the new product to those unfamiliar consumers. Some manufacturers may rely on the retailer's sales effort, such as the in-store layout or the assignment of sales assistants, to advocate their products. Other manufacturers may introduce the products straightly to the consumers by using media advertising (e.g., newspaper and television) or the label of professional certifications (e.g., ISO, 9000). All these ways can be categorized as quality disclosure that conveys explicit product information to enhance the consumer's awareness and valuation.¹ However, the fundamental difference is that some of them are conducted *directly* by the manufacturer, while the others are accomplished *indirectly* through the retailer.

In an influential paper, [10] classifies the diversity of disclosure formats into two categories: direct disclosure via the manufacturer and indirect disclosure via the retailer. He further investigates the firms' endogenous choices of quality information disclosure in a supply chain, and examines which disclosure format will arise for the firm from

either an ex-ante or an ex-post perspective. Nonetheless, one feature ignored is that the retailer, who is typically not involved in the production process, may initially have no prior knowledge of the manufacturer's product characteristics [6]. This consequently prevents the retailer from immediately participating in the disclosure process, unless the manufacturer has first provided such product information through their transactions, for example by factory tour or large-scale sales training.² On the other hand, even though the retailer has already received the product information, she may be still reluctant to advocate the product, unless the costly disclosure process is justified by her own profitability.

The above discussion implies that indirect disclosure requires a substantial effort by the manufacturer to incentivize the retailer. Otherwise, private quality information may not be voluntarily disclosed by the retailer. Motivated by this complexity, our paper seeks to provide a complete picture and generates some novel insights regarding the quality disclosure in a supply chain setting. We address the following research questions. First, what are the firms' equilibrium disclosure and pricing strategies, when the manufacturer privately observes the quality information? Second, how do these equilibrium disclosure

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¹ Note that there are also other forms of marketing communications, for example, preservative advertising that contains no product information [14] and sales promotion that expands the market demand by price discount. Nonetheless, in this paper we will focus exclusively on the informative communications.

² Karl Bearmarth, Senior VP of Marketing at JVC, once mentioned: "The new JVC training site helps ensure that customers coming into authorized JVC dealers are met by knowledgeable retail salespeople who can speak with confidence about JVC products..... Our primary goal in establishing online training is to make sure that our retail partners always have the most up-to-date information about our product line." (Source: <http://www.internetretailer.com/2006/08/29/creative-channel-services-jvc-launch-retail-training-program>).

strategies influence the individual's and supply chain's ex-post payoffs? Third, how to ex-ante allocate the firms' disclosure costs so as to increase the supply chain efficiency?

To answer these questions, we construct a *two-layer* disclosure model that consists of a manufacturer with private product information, an independent retailer who possesses the pricing power, and a representative consumer. The manufacturer first observes his product's quality, and then decides whether to reveal this information exclusively to the retailer (e.g., by factory tour) or directly to the consumer (e.g., by advertising). Afterwards, the retailer decides the retail price and whether to costly forward the product information to the consumer if only the manufacturer chooses indirect disclosure. Finally, the consumer updates the belief of product quality and decides whether to buy the product.

We identify several economic forces that determine the equilibrium disclosure strategies. Indirect disclosure serves as the manufacturer's priority choice when the product quality is relatively high. This helps the manufacturer *free ride* on the retailer's sales force, as he partially absorbs the disclosure cost by only convincing the retailer. Note this free-riding incentive is so strong that the manufacturer may even reduce the wholesale price to invite the retailer. In contrast, direct disclosure requires a more costly work from the manufacturer, since he probably has to spend more to convince the whole market of consumers (e.g., advertising) than a single retailer (e.g., factory visit). As a result, this option is adopted only if the manufacturer's disclosure cost is relatively low; otherwise, he will not choose it across the entire quality level. There is another possible strategy, in which the manufacturer and the retailer both withhold the product information (non-disclosure) when the product quality is sufficiently low or their disclosure costs are high.

These disclosure strategies vary in the ex-post quality level and the disclosure costs, thereby leading to some unintended consequences. First, the retail price, the retailer payoff, and the supply chain payoff can *increase* simultaneously when the product quality *goes down*. This phenomenon occurs when the manufacturer strategically switches from indirect disclosure to direct disclosure, and its intuition is as follows. To facilitate indirect disclosure, the manufacturer has to offer a sufficiently low wholesale price to incentivize the retailer when the revealed product information is not that attractive. However, once this wholesale price reduction becomes too costly, the manufacturer shall switch to direct disclosure instead and charge a higher wholesale price to compensate the increased disclosure cost. Consequently, a higher retail price arises. Meanwhile, this change of disclosure format also drives up the retailer's payoff. Because under such a circumstance, the retailer no longer needs to participate in the costly communication process, even though she has to endure a higher wholesale price for a product with lower quality.

Second, we show that a decentralized supply chain may generate a higher ex-post payoff than the integrated supply chain, which is in strict contrast with the prediction from double marginalization argument. This unintended result arises when both types of the supply chain withhold the product information, and we articulate its intuition as follows. The marginal profit from revealing the quality information is always higher in an integrated supply chain than that in the decentralized supply chain; thus, it gives the integrated supply chain more incentive of disclosure. Nonetheless, this reversely pulls down the consumer's valuation of product quality once he observes non-disclosure in the integrated supply chain. In this sense, a low disclosure cost could be detrimental for the supply chain's payoff, in particular if the ex-post quality level is sufficiently low. Since the consumer possesses a higher valuation in the decentralized supply chain when no product information is released, a higher retail price arises and thus leads to the prediction that goes against the double marginalization implication.

We further investigate how to allocate the channel's disclosure costs so as to achieve a higher supply chain ex-ante payoff. The result shows

that with a fixed disclosure cost, it is never beneficial for the supply chain to share the disclosure costs between the firms. This is because the equilibrium disclosure structure (denoted by the disclosure cutoff point) can exert two conflicting effects on the supply chain's expected payoff: a higher cutoff point prevents the supply chain in extracting more profits from disclosure, but it facilitates the supply chain to set a higher retail price when withholding the information. This subsequently leads to a U-shaped relationship between the disclosure cutoff point and the supply chain's payoff; thus, the boundary of cutoff point can be achieved when either the manufacturer or the retailer bears the entire disclosure cost. Moreover, we demonstrate that this pivotal impact of cost allocation remains robust even when we use a revenue sharing contract to eliminate the supply chain decentralization in the pricing subgame. As a result, when the retailer takes full charge of disclosure cost it generates a payoff that is even higher than that in the centralized supply chain.

The rest of this paper is organized as follows. Section 2 reviews relevant literature. In Section 3, we lay out the model setup. The analysis of optimal disclosure strategies and their implications is presented in Section 4. Section 5 investigates the impacts of disclosure costs on the supply chain's ex-ante payoff. Section 6 discusses the extensions and Section 7 concludes the paper. Proofs are presented in the Appendix.

2. Literature review

Our paper belongs to the vast literature on voluntary revelation of product information (e.g., [7,15]). [9,18] first study this issue in a monopolistic case and find that any private information is voluntarily revealed as long as the disclosure process is costless. Since then, researchers start to identify the factors that lead to partial information disclosure, such as the disclosure and acquisition costs [12,17,20], the product's multiple attributes [21], the consumer's unawareness or the limited understanding of quality [8,13], and the market competition [4,11]. Besides, there are also some papers that study voluntary information revaluation by empirical analysis [1,22]. This paper investigates how the disclosure costs and the members' conflicts of interest could influence their communication behaviors. To this end, we conduct a bilateral monopoly model in an indirect channel context. In contrast, the majority of the above literature focuses exclusively on a direct channel setting.

In a supply chain setting, [19] examine the retailer's incentive of disclosing the market information to her supplier who is able to increase the sales demand. Similarly, [2] show that a retailer may share her sensitive financial information with the supplier when taking the horizontal competition into account. In a reverse pattern, [5] study the strategic information sharing issues in a two-echelon supply chain. They assume that the supplier may process some private demand information and can decide whether to share it with the retailer and to help the retailer better forecast the demand. In a dual-channel setting, [3] also investigate the firm's incentive of sharing the advertising cost, and find that the manufacturer may free-ride on the retailer's advertising/promotion while the retailer has an adverse attitude toward it. However, they do not incorporate the consumer's strategic behavior into their analysis.

As aforementioned, [10] studies the information disclosure problem in the indirect channel, which is also the closest paper to our work. However, the significant differences in this paper are as follows. First, unlike his assumption that either manufacturer or retailer can independently disseminate the quality information, we claim that indirect disclosure inevitably entails the efforts of both upstream and downstream firms. In other words, the manufacturer may have to first convince the retailer and then induce her to advocate the product. Second, we allow the heterogeneous disclosure costs at different levels, while [10] assumes that the disclosure costs are homogeneous. Cost heterogeneity is the driving force for the variety of equilibrium

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