Incentive provision for demand information acquisition in a dual-channel supply chain

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ABSTRACT

This paper studies an endogenous adverse selection model in a dual-channel supply chain setting, in which the manufacturer can offer a menu of contracts to induce the retailer to costly acquire private demand information. We derive the manufacturer's optimal incentive provision decision and show that although the increase of acquisition cost results in higher distortion effect on the retailer's selling quantity, such a distortion effect can be alleviated in a dual-channel setting. The manufacturer's incentive provision exhibits a threshold policy. When demand variation is high and information acquisition cost is low, acquiring demand information does not necessarily benefit the retailer.

1. Introduction

With the rapid development of third-party logistics and information technology (IT), many manufacturers, such as Epson, Sony, and Cisco Systems, have established their own direct selling channels (Chiang et al., 2003). The establishment of a direct selling channel is normally beneficial to the manufacturer, as it endows the manufacturer with direct control of distribution and pricing flexibility (Tsay and Agrawal, 2004). However, its impact on the retailer's side is mixed: direct channel would intensify the downstream competition but also incentivize the manufacturer to cut down the wholesale price (e.g., Liu and Zhang, 2006; Arya et al., 2007; Khouja and Wang, 2010).

The establishment of direct selling channel has been extensively examined in the literature, and a common assumption is that the demand information is observable to both the manufacturer and retailer. Nonetheless, in practice, it is more likely that the manufacturer has no access of demand information, due to its remoteness to the end-market and lack of acquisition tactics. In contrast, the retailer is more professional at acquiring market information. For example, a retailer can invest substantial resources in establishing demand forecasting systems (Shin and Tunca, 2010; Ausfoodnews.com, 2012), employing personnel to gather and process the data obtained (Guo, 2009; Li et al., 2014), or hiring external experts who have professional knowledge in a specific field to carry out the forecasting (Fu and Zhu, 2010). Amazon, the world's largest on-line retailer, is hiring scientists who are specialized in enabling machines to make demand forecasts for its research teams in New York and Berlin (Mizroch, 2015). Given the retailer's superior knowledge of demand information, the manufacturer needs to consider how to induce the retailer to share her privately observed demand information with him, which is particularly valuable in a dual-channel setting. This is because compared to the single-channel setting, demand information influences not only the manufacturer's wholesale pricing decision in the retail channel, but also his selling quantity decision in the direct selling channel.

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Although the issue of information asymmetry has been investigated by some researchers in a dual-channel setting (e.g., Cao et al., 2013; Li et al., 2014; Li et al., 2015), a common assumption is that the retailer is freely endowed with superior demand information. Nonetheless, based on the above discussion, in practice, acquisition should be an endogenous decision for the retailer, given that such a process could be quite costly. According to the data, in the United States alone, the annual spending of firms on information acquisition is approximately $6.7 billion and such a number has already increased to $18.9 billion worldwide (Shin and Tunca, 2010; Guan and Chen, 2016). Therefore, whether the retailer has the incentive to costly acquire the demand information becomes questionable, especially in a dual-channel supply chain setting wherein the establishment of the direct selling channel would potentially intensify the market competition. On the other hand, from the manufacturer's perspective, is it profitable for him to incentivize the retailer to undertake the costly acquisition under such a circumstance? If the manufacturer does so, how should he design the optimal contracts to induce the retailer to share her private demand information?

To answer these questions, this paper seeks to conduct a novel approach by relaxing the assumption of costless acquisition and to investigate the manufacturer's contract design and the retailer's incentive of acquisition in a dual-channel context. We consider a manufacturer selling to end consumers through his own direct selling channel and a retailer in the traditional retail channel. The market demand is uncertain initially and could exhibit two possible values: a high demand and a low demand. At the beginning, the manufacturer determines whether or not to provide incentives for the retailer to costly acquire demand information. To achieve this, the manufacturer can either provide a contract menu to induce information acquisition or offer one single contract to induce non-acquisition. Then, the retailer chooses whether or not to costly acquire demand information. If she acquires information, she becomes informed of her demand type; otherwise, she remains uninformed.[1] Next, the retailer either accepts and chooses one contract consistent with her demand type or just rejects the manufacturer's contract offer. Meanwhile, the manufacturer determines the selling quantity in the direct selling quantity accordingly. Finally, the demand is realized and payments are made as stipulated.

To our knowledge, this paper belongs to the few ones considering the endogenous adverse selection problem (e.g., Taylor and Xiao, 2009; Chen et al., 2016; Huang and Yang, 2016). Complementing the extant research, we extend the game context from a standard supply chain setting to a dual-channel supply chain. We further characterize the manufacturer's optimal contracts by incorporating the substitution effect, the demand variation, and the information acquisition cost. Combining these elements, our analysis yields several interesting results speaking to the strategic interactions between the manufacturer and the retailer, which can be elaborated as follows.

To incentivize the retailer, it is generally believed that the manufacturer has to distort the selling quantity, which consequently hurts his profitability. However, we show that such a distortion effect can be alleviated in the dual-channel setting, as now the manufacturer has the flexibility in adjusting his selling quantity in the direct selling channel. Similarly, to prevent the retailer from acquiring information, the manufacturer decreases the selling quantity in the retail channel to eliminate the retailer's motivation of acquiring information, and correspondingly, increases the selling quantity in the direct selling channel. During this process, we surprisingly find that the retailer is able to obtain extra profit beyond the reservation profit, even if she has no superior demand information. From the manufacturer's perspective, there always exists a threshold for the retailer's information acquisition cost, below which the manufacturer prefers to induce information acquisition. The manufacturer's optimal incentive provision decision also gives rise to some interesting payoff implications. For example, the retailer's optimal expected profit is weakly decreasing in the information acquisition cost, whereas the expected profits of both the manufacturer and the supply chain exhibit non-monotonic relationships with respect to the retailer's information acquisition cost.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 presents the model. The manufacturer's optimal incentive provision decision is presented in Section 4. Section 5 compares the results with the single-channel setting. Section 6 concludes the paper. All proofs are presented in the Appendix.

2. Literature

This paper also falls into the vast literature that studies the optimal decisions in a dual-channel supply chain (see, e.g., Liu and Zhang, 2006; Arya et al., 2007; Hua et al., 2010; Chen and Chang, 2012; Liu et al., 2016; etc.). In this stream of literature, some studies have examined the impact of the establishment of the direct selling channel on the performance of the retailer and the manufacturer. For example, Liu and Zhang (2006) show that the establishment of the direct selling channel impairs the retailer's profitability. However, some researchers find that the establishment of the direct selling channel does not necessarily hurt the retailer (see, e.g., Arya et al., 2007; Ha et al., 2016). Arya et al. (2007) indicate that the retailer can benefit from the establishment of the direct selling channel through a reduced wholesale price. Ha et al. (2016) further show that a higher manufacturer's cost of quality could benefit the retailer in a dual-channel supply chain.

The above literature on supplier encroachment usually assumes symmetric information. However, in practice, retailers can acquire demand information and have superior private demand information to the supplier. When information is asymmetric between the supplier and the retailer, the consequences of supplier encroachment may be varied. Li et al. (2014, 2015) study the optimal contracting with asymmetric demand information in a dual-channel supply chain by utilizing the adverse selection model and the signalling model. Cao et al. (2013) study the optimal contract design in a dual-channel supply chain when the retailer has private cost information. The above literature assumes that the retailer is freely endowed with private demand information. However, in practice, the retailer usually needs to exerting costly effort to acquire private demand information. Thus, the present paper complements an

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[1] Denote the retailer who finds that the demand is in the high (low) state as the High (Low) type retailer.