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Pricing strategies of a dual-channel supply chain with risk aversion

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ABSTRACT

We investigated the effect of risk aversion on the optimal policies of a dual-channel supply chain under complete information and asymmetric information cases. We determined that the optimal value added only depends on the value-added cost. The optimal prices under a risk-averse case are lower than those in a risk-neutral case. Information asymmetry increases wholesale and retail prices but reduces direct sale price, and tends to engender inefficiency. The value of information increases with the mean of the manufacturer's estimation about the retailer's risk aversion.

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1. Introduction

Many internationally known companies, such as Nike, Apple, Samsung, and Sony, have directly sold to the customers via their websites (Cao et al., 2013). The direct sale channel is different from the traditional distribution channel. In the direct sale channel, the products are distributed directly from the manufacturer to the consumer; whereas in the traditional model, products are distributed from the manufacturer to the retailer, who then sells them to the consumer. In the traditional distribution model, the retailer acts as a middleman between the consumer and the manufacturer. The direct sale model helps manufacturers reduce costs, increase sales revenue, and open up new markets (Chen et al., 2012). Consequently, many manufacturers have adopted dual-channel structures to satisfy demand from the various customer segments and cover those market segments that are inaccessible to the traditional single retail channel (Cai, 2010). In the dual-channel supply chain, the typical relationship between the manufacturers and retailers is one of cooperation and competition (Cai, 2010). As a result, the channel conflicts between the two parties further complicate the dual-channel supply chain. The existing research on the dual-channel supply chain has primarily focused on the pricing and coordination decisions. Researchers constantly assume that the market members are risk neutral and possess complete information (Xu et al., 2014).

However, the business environment of dual-channel supply chain has evolved to be increasingly complex. Such an environment is characterized by high uncertainty and rapid and frequent changes (Wu et al., 2010). Acceleration in the globalization of markets has also increased market uncertainty and risk. The highly changeable nature of the market has spurred participants to develop varying attitudes toward risk. Specifically, the capacity of an enterprise to bear risk is seen to progressively affect its overall revenue. Enterprises also have to consider their capacity to bear risk when looking at expected

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profit maximization. Some enterprises would rather sacrifice some of their benefits to avoid risks. Therefore, identifying and understanding the characteristics of partners with a low tolerance for risk and a high degree of risk aversion has critically important and practical applications. Some enterprises have become so risk averse that they would rather sacrifice benefits than suffer risk. Some decision makers have responded by fiercely protecting their information, thereby increasing others' difficulty in estimating the level of risk they are undertaking. This scenario creates an asymmetric information case, which adds a new dimension to research.

Thus far, the extant literature has scarcely addressed the effect of risk aversion on decision making in dual-channel supply chains. This failing has motivated us to ask the following research question: How does risk aversion affect partners' prices, profits, and the dual-channel supply chain profit under complete information and asymmetric information? This paper primarily aims to investigate the effect of information asymmetry on optimal policies when dual-channel supply chain agents are risk averse.

In this paper, the degree of the retailer's risk aversion is assumed to be her private information, and the effect of asymmetric information on all partner decisions in a dual-channel supply chain setting is analyzed. The paper contributes to the literature by providing a framework for simultaneously assessing the issues of information asymmetry, dual-channel supply chain, and risk aversion behavior. The contribution of this study is threefold. First, we developed a model that simultaneously considers information asymmetry, dual-channel supply chain, and risk aversion behavior. Second, we derived the optimal decisions of risk aversion supply chain members in both the complete information and asymmetric information settings. Third, we characterized the effect of the parameters on the members' decisions and profits.

We also made some interesting observations. First, in the decentralized supply chain case with complete information, the value added to the basic product by the retailer only depends on the efficiency parameter for the retailer's value-added cost. The retail and the direct sale prices increase, whereas the degree of risk aversion toward them decreases. Second, if the manufacturer overestimates the degree of the retailer's risk aversion, his wholesale and retail prices will be higher in the asymmetric information case, but the direct sale price will be lower. Third, the expected profit of the manufacturer is always lower in the asymmetric information case. In this setting, his profit loss can be considered the information cost that he must pay if he wants the retailer to share information. In addition, the profit loss changes more rapidly with the degree of risk aversion varying quickly. Fourth, if the manufacturer overestimates the degree of retailer's risk aversion, the retailer's expected profit will be lower than if she shares her risk aversion information with the manufacturer. Finally, the expected profit of the total supply chain would be higher in a complete information scenario.

The rest of our paper is organized as follows. In Section 2, we summarize the relevant literature. In Section 3, we describe the problem. In Section 4, we analyze the optimal decision in a complete information setting. In Section 5, we present an optimal decision model in the asymmetric information case and compare the two different information cases. In Section 6, we provide numerical examples. Finally, in Section 7, we present the conclusions and managerial implications.

2. Literature review

This paper provides a framework for simultaneously assessing the issues of information asymmetry, dual-channel supply chain, and risk aversion behavior. This framework is related to the intersection of dual-channel supply chain, risk aversion, and asymmetric information. Thus, this section reviews and analyzes the dual-channel supply chain, risk aversion, and information asymmetry.

Price competition and coordination have attracted considerable attention in the study of a dual-channel supply chain in the past few years. The existing research on dual-channel supply chain coordination has chiefly focused on pricing and designing contract under complete information. Meixell and Gargey (2005) reviewed decision support models for the design of global supply chains and assessed the fit between the research literature in this area and the practical issues of global supply chain design. Samar et al. (2008) examined the information sharing of value-adding retailers in a dual-channel hi-tech supply chain, based on the Stackelberg game. Yao et al. (2008) considered a supply chain consisting of one supplier and two value-adding heterogeneous retailers and modeled a supply chain with a three-stage game-theoretic framework. Equilibrium prices and added values exist under certain conditions (Yao et al., 2008). Heydari (2014) studied the service level coordination in a two-stage supply chain when a retailer is confronted with uncertain lead-time due to shipping time instability. Chen et al. (2012) investigated a manufacturer's pricing strategies in a dual-channel supply chain and pointed out that the manufacturer's contract with the wholesale and direct channel prices can coordinate the dual-channel supply channel.

The preceding literature on the dual-channel supply chain assumed that the partners are risk neutral. However, with increasing market uncertainty and fierce competition, the capacity of an enterprise to bear risk is seen to progressively affect its overall revenue. Enterprises also have to consider their ability to bear risk when looking at expected profit maximization. Some enterprises would rather sacrifice some of their benefits to avoid risks. Therefore, identifying and understanding the characteristics of partners with a low tolerance for risk and a high degree of risk aversion has critically important and practical applications. Recently, researchers studied the influence of the decision maker's attitude toward risk in supply chain decision-making behavior. They used financial tools, such as mean variance, value at risk, conditional value at risk, and prospect theory, to describe the risk associated with supply chains (Daniel and Amos, 1979; Wu et al., 2010). Gan et al. (2004) developed coordinating contracts of supply chains with risk-averse agents and designed a contract to achieve the Pareto-optimal solution. Gan et al. (2005) is one of the seminal papers in this area, they shown that the well-known revenue sharing

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