Double moral hazard in a supply chain with consumer learning

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ABSTRACT

When an innovative product is introduced into the market, consumers are often uncertain about the product value. Over time they may learn the value of product. This paper studies the impact of consumer learning on the firms' marketing efforts and revenue sharing strategies in a supply chain that sells an innovative product to consumers over multiple periods. Both the supplier and the retailer can exert marketing efforts to influence consumers' beliefs about the product and improve the product demand. Because the supplier and the retailer are independent entities with self-interested objectives, double moral hazard exists in the supply chain. We find that the supplier and retailer exert more marketing efforts in the presence of consumer learning but the marketing efforts decrease as consumers learn more about the product. We also examine the revenue-sharing strategies and find that supplier shares more revenue to the retailer when they cooperate for a longer time horizon. The total profit of the supply chain may be higher when there is information asymmetry between the supplier and retailer. This finding suggests that information sharing is not always beneficial to improve supply chain coordination.

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1. Introduction

Valuation uncertainty often arises when innovative products are introduced into the consumer market. The consumers, without experiencing the innovative products, can rarely predict with certainty the values of the products [19]. For example, when a new hybrid car is launched, a consumer might not be able to predict its fuel efficiency and battery life. When a new game console is released, a consumer might not be able to anticipate precisely the diversity and amusement of the games compatible with the console. Other newly innovated electronic products, such as smart phones and tablet computers, have similar issues. This scenario is also prevalent in agribusiness, software, and apparel industries.

Over time consumers may obtain more information about a product from multiple sources and evaluate the product better [23]. For example, the consumers can view professional product reviews from magazines or peer consumer reviews published online [8,12]. They can also learn the historical sales prices and sales numbers of products via e-commerce websites or through companies' earnings releases. For example, eBay posts the past transaction records of listing items on its listing page; Apple's earnings report disclosed the sales numbers of its flagship products—17.07 million iPhones and 11.12 million iPads during the last quarter of 2011 [1]. Compared with professional and consumer product reviews, product sales

numbers are more difficult to be manipulated and hence convey more reliable information about the product. In this paper, we focus on consumer learning through product sales.

Firms in a supply chain often exert marketing efforts to change their consumers' perceptions of the product values. Purchasing television or online advertisements, hiring public relationship companies to publish positive product articles in magazines, and/or offering various promotional incentives such as gift with purchase and next purchase discount are some of the mechanisms by which firms attempt to influence consumer perceptions. It has been recognized that marketing activities in the supply chain often generate positive externalities [14]. As one firm's marketing effort improves the brand image and boosts the product demand, all firms participating in the supply chain may benefit. However, in most practical situations, the full scope of the firm's actions (including marketing efforts) is not observable by other firms in the supply chain. The firm may avoid spending on the costly (and sometimes unobservable) marketing effort because it would not like to share the resultant benefit with its supply chain partners. This is how double moral hazard arises [2,15].

In this paper, we consider a supply chain with consumer learning and double moral hazard. The supply chain consists of supplier, retailer, consumer and has the following features. First, the consumers are uncertain about the true value of the innovative product. Over time, the consumers may learn more about the product value from prior sales of the product. In particular, higher product sales signal a higher product value to the consumers, which yields a higher product demand. Second, the firms (both the supplier and retailer) in the supply chain can exert marketing efforts to change the product sales. Finally,

a firm's marketing effort is unobservable by any other firm or consumers in the supply chain. This leads to the issue of double moral hazard.

This paper aims to explore the impact of consumer learning on the firms' marketing strategies and supply chain coordination in the presence of double moral hazard. In particular, this paper answers the following questions. First, when the consumers are uncertain about the true value of a new product and learn the product value from prior sales, how do the supplier and retailer exert marketing efforts to improve the product demand? Do the marketing efforts increase or decrease over a period of time? Compared with the case without consumer learning, do the firms exert more or less marketing efforts? The answers to these questions provide important implications on understanding the firms' marketing strategies.

The second issue concerns the impact of consumer learning on supply chain coordination. We consider a linear revenue-sharing scheme in which the supplier decides the revenue sharing ratio. There are several questions that need to be addressed. How do the firms share the revenue in the supply chain in the presence of consumer learning? Is the supplier willing to share more or less revenue with the retailer when the two entities cooperate over a longer time horizon? Compared with the case without consumer learning, does the supplier share more or less revenue with the retailer? The answers to these questions help us gain greater insight on supply chain coordination for innovative products.

The third and last issue relates to the role of information in the supply chain with consumer learning and double moral hazard. Conventional wisdom suggests that information asymmetry undermines supply chain coordination and firms therefore strive to eliminate information asymmetry. With consumer learning, does double moral hazard still undermine the profit of the supply chain? Should the supply chain always eliminate information asymmetry between the trade partners? A better understanding of the role of information enables the entities in the supply chain to improve the management of information in the supply chain.

Our research results depict several interesting findings. We find that the supplier and retailer exert more marketing efforts to increase the product demand in the case with consumer learning compared with that without consumer learning. This result holds even though the consumers always correctly predict the firms' demand-boosting strategies and adjust their beliefs. Over time, consumers learn more and predict the product value more accurately. As a result, firms exert less marketing efforts because the efforts have less impact on the consumers' perception.

The revenue sharing ratio is higher when the entities in the supply chain cooperate over a longer time horizon. A higher revenue sharing ratio decreases the supplier's incentive to exert effort whereas consumer learning negates this effect. Compared with the case without consumer learning, the supplier shares more revenue to motivate the retailer to increase the latter's effort. With a longer time horizon, the impact of consumer learning on the supplier's marketing effort is stronger, leading to a higher revenue sharing ratio.

This paper also has a counterintuitive finding about the role of information. The results show that the total profit of the entities in the supply chain may be higher when there is asymmetric information between the supplier and the retailer. This stands in contrast to the findings in the existing literature that double moral hazard undermines the total profit of firms. With double moral hazard, the firms in the supply chain tend to exert less effort because the benefit will be split amongst the partners. In this paper, we find that consumer learning motivates firms to exert higher marketing efforts. This positive effect of consumer learning mitigates the adverse consequences of double moral hazard. When the supplier has complete information and thereby decides the marketing efforts for all the entities in the supply chain, the supplier demands too much marketing efforts for the purpose of misleading consumers. Therefore, better information

in the supply chain does not always improve the profit of the supply chain. Double moral hazard may be beneficial in presence of consumer learning. This is one of the major findings of this research.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 outlines the model. Sections 4 and 5 analyze the cases without consumer learning and with consumer learning respectively. Section 6 compares the results in different cases and conclusions are presented in the last section of the paper.

2. Literature review

This paper draws upon and contributes to several streams of literature as reviewed in this section. First, this paper relates to the literature on moral hazard. There is a large body of literature examining the issue of moral hazard in supply chains [4,6,7]. These studies only consider the agency issues on the retailer side. In many practical situations, both the suppliers and retailers can invest in costly efforts to improve the performance of the supply chains. In this paper, we consider both parties' efforts which comes down to a double moral hazard problem.

Double moral hazard has also been examined in the literature. Holmstrom examines moral hazard in team (partnership) and shows that any sharing rule subject to the budget balancing constraint cannot achieve the first-best outcome in team production [13]. Corbett and Decroix consider a supply chain where the consumption of indirect materials is endogenously determined by both the supplier's and the retailer's efforts [5]. The supplier and retailer have countervailing incentives to exert consumption–reduction efforts as the retailer saves but the supplier loses from a reduced consumption. They find that a simple shared-savings contract is possible to increase channel profits. Lal studies the royalty structure and the monitoring technology of revenue sharing contracts in a franchising setting [16]. He finds that a contract with royalty fee can provide appropriate incentives to both the franchisor and the franchisee. Bhattacharyya and Lafontaine model a principal and agent problem with double moral hazard [2]. They show that a simple linear contract in which the principal and the agent share the output in addition to a fixed monetary transfer yields the second-best outcome (complete information results in the first-best outcome). Eswaran and Kotwal investigate the use of revenue-sharing contract in the presence of double moral hazard [9]. They find that a revenue sharing contract is advantageous when the class structure is polarized—the landlord lacks production capability and the tenants have little management capability. The current paper contributes to this stream of literature by investigating double moral hazard in the presence of consumer learning.

This paper also relates to the literature on supply chain coordination with strategic consumers, who decide on the timing of purchase. Su and Zhang study a newsvendor problem with forward-looking consumers who can rationally anticipate future product sales and availability [22]. They find that the seller's stocking level is lower in the case with strategic consumers as opposed to the case with nonstrategic consumers and a decentralized supply chain yields a higher profit. Swinney investigates the value of quick response production for a firm selling to a forward-looking consumer population [23]. The consumers are uncertain about their valuations for the product at the start of the selling season but learn their valuations upon receiving private signals later. Swinney finds that the quick response strategy does not always improve the firm's profit with strategic consumers [23].

Recently a number of papers consider consumer learning using multi-period models. Gallego, et al. investigate a firm's optimal pricing policy when the firm's markup policy in the current season changes the consumers' expectation and purchasing behaviors in future seasons [10]. Gallego et al. find that a single-price policy is optimal if all consumers are strategic and demand is known to the seller [10]. Ovchinnikov and Milner numerically illustrate the value of offering end-of-period deals when consumers learn to expect the firm's discount policy and wait to buy [21]. They consider consumers with