



Integrated or decentralized: An analysis of channel structure for green products



Wei Xing^{a,*}, Jie Zou^a, Tian-Liang Liu^b

^aSchool of Management, Qufu Normal University, Rizhao 276826, Shandong, China

^bSchool of Economics and Management, Beihang University, Beijing 100191, China

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ABSTRACT

This paper focuses on the interaction of channel structure with green product development in a competitive setting. A game-theoretic model is constructed in which one manufacturer sells a green product, whereas another offers a conventional product in a same consumer market. The two manufacturers initially select either the integrated or decentralized channel strategy simultaneously. The green manufacturer subsequently determines the green level of its product. Finally, the two manufacturers compete with each other directly or indirectly through exclusive independent retailers. Our analysis indicates that in equilibrium the conventional manufacturer adopts the decentralized channel strategy to avoid direct competition with the green manufacturer by inserting an independent retailer when the conventional product has a small potential market share and the product substitutability is high. Otherwise, the conventional manufacturer selects the integrated channel strategy to seek channel efficiency. However, the green manufacturer always adopts the integrated channel strategy to pursue channel efficiency because of the opportunity to design an appropriate green level and adjust the market demand for the green product. This additional decision provides the green manufacturer with an alternative tool for competing with its rival. Further analysis reveals that the two manufacturers encounter a prisoner's dilemma given a relatively high product substitutability. The best result (i.e., the situation in which both manufacturers adopt the decentralized channel strategy) cannot be achieved in equilibrium. We also evaluate the effect of channel structure strategy on total environmental quality.

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1. Introduction

Two factors should be considered when a firm intends to introduce a green product into a consumer market. First, the firm should select or design an appropriate channel structure. Two channel structures are popularly observed in practice, namely, distributing through independent intermediaries or selling directly (Kotler, 1980). Firms can utilize a wide variety of intermediaries to distribute their products and ensure extensive accessibility to consumers (Ingene & Parry, 2004; McGuire & Staelin, 1983). However, selling through independent intermediaries might make a firm lose the control of its distribution channel. The firm and its independent retailers seek their respective high-profit margins. Hence, the retail price is higher, and the sale quantity and profit are lower than those of a vertically integrated channel. This phenomenon is identified as “double marginalization” effect (Spengler, 1950). A large number of firms insist on selling through

integrated channels, such as catalog sales and company stores, to better maintain sale forces and closely deal with consumers.

Second, opting to go green requires upfront investment (Ghosh & Shah, 2012; Swami & Shah, 2013). A firm should design an appropriate green level (degree) of the product in which the consumers can afford to buy. Therefore, the firm must consider the tradeoff between market demand and the investment of green product development, and design an appropriate green level to achieve the best possible performance. This aspect raises the question on how channel structure interacts with green product development and further affects the decisions and profits of firms in a setting in which a green product competes with a conventional (traditional) product. The effects of channel structure from the perspective of the public and governments must also be investigated. In particular, how channel structure strategy affects total environmental quality or which channel structure is preferred by the public and governments must be determined.

Although a number of studies have focused on green product development (e.g., Swami & Shah, 2013; Xie, 2015) and channel structure (e.g., McGuire & Staelin, 1983; Yang, Shi, & Jackson,

* Corresponding author.

E-mail address: xingweimail@gmail.com (W. Xing).

2015), no existing literature has theoretically investigated the efficacy of a combination of green product development and channel structure when competition exists in two categories of substitute products. To fill this gap in the literature, we develop a game-theoretic model in which one channel sells a green product and the other offers a conventional product in a same consumer market. Without loss of generality, the upstream members of the channels are referred to as the green manufacturer and the conventional manufacturer, and their downstream counterparts are referred to as the green retailer and the conventional retailer, respectively. The two manufacturers initially engage in a channel game by simultaneously choosing between integrated channel strategy and decentralized channel strategy. The green manufacturer subsequently decides the green level of its product. Finally, the two manufacturers compete with each other directly or indirectly through independent retailers.

Our findings suggest that the conventional manufacturer selects the decentralized channel strategy in equilibrium to avoid direct competition with the green manufacturer by inserting an independent retailer if the conventional product has a relatively small potential market share. Otherwise, the conventional manufacturer selects the integrated channel strategy to seek channel efficiency. However, the green manufacturer always adopts the integrated channel strategy to pursue channel efficiency because it has the opportunity to design an appropriate green level to adjust the market demand for the green product. This additional decision provides the green manufacturer with an alternative tool for competing with its rival, and does not have the incentive to insert an independent retailer to avoid the competition at the retail level. An interesting finding is that the two manufacturers encounter a prisoner's dilemma if the product substitutability is relatively high. The best result (i.e., the situation in which both manufacturers adopt the decentralized channel strategy) cannot be achieved in equilibrium. Selecting the "safe" strategy (i.e., the integrated channel strategy) is the final result for both players.

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the game-theoretic models. Section 4 initially presents the channel choice of a manufacturer given that its rival has adopted the integrated or decentralized channel strategy, and subsequently discusses the equilibria of the channel game. Section 5 presents the concluding remarks. The proofs are provided in Appendix B.

2. Literature review

The research on green product development has received growing attention in recent years. The majority of the literature focuses on different issues in a sole green supply chain, such as supply chain coordination (Ghosh & Shah, 2012; Swami & Shah, 2013; Zhang, Wang, & You, 2015), regulation under different supply chain structures (Xie, 2015), cost sharing (Ghosh & Shah, 2015), production modes (Zhang, Wang, & Ren, 2014), social responsibility (Ni, Li, & Tang, 2010), and the role of technologies (Su, Wang, & Ho, 2012). The aforementioned studies focus on a sole supply chain and do not involve channel choice strategy. Conversely, the present paper considers a competitive setting in which one supply chain sells a green product and the other offers a conventional product in a same consumer market. Chen (2001), Krishnan and Lacourbe (2010), and Yenipazarli and Vakharia (2015) examine the green product development decision of a monopoly that is faced with two market segments. Although the competition between the green and conventional products is considered, they do not involve supply chain structure and channel efficiency. Three studies consider the competition between two supply chains. Conrad (2005) analyzes the effect of consumer environmental concern on product

characteristics and pricing strategy. In contrast, we focus on the effect of channel choice rather than product characteristics. Liu, Anderson, and Cruz (2012) analyze the interaction of consumer environmental awareness with competition intensity. Different from ours, the two supply chains they studied only compete for green products. Hafezalkotob (2015) considers a price competition model of green and regular supply chains and focuses on the effects of government's tariffs on the strategies and performance of the supply chain members.

There has been a rich body of literature focusing on exclusive channel with competition. Our paper is closely related to the literature on the choice of channel structure (i.e., integrated or decentralized supply chain) in a competitive setting. McGuire and Staelin (1983) find that a high substitutability drives firms to adopt integrated supply chain, while a low one forces firms to use decentralized channel. Moorthy (1988) reveals that whether a firm adopts the decentralized or integrated channel depends on the demand substitutability or complementary of their demands and pricing strategies. Wu, Petruzzi, and Chhajer (2007) investigate how demand uncertainty and production cost influence the channel structure strategy of firms. They find that the increase of demand uncertainty may drive firms to adopt the integrated channel. Xiao and Choi (2009) suggest that the risk-averse attitude of the players can affect channel equilibrium, and find that the firms adopt decentralized channel if their risk sensitivity is high. Yang et al. (2015) explore the effects of the asymmetry characteristics from brand equity and product substitutability on equilibrium channel structures. The present study follows the research direction of McGuire and Staelin (1983) and incorporates the characteristics of the green product in the demand function to ascertain how the green product development decision affects the channel structure strategy and total environmental quality. Another stream of research in this field focuses on various issues under an exclusive channel structure, such as the effect of scale economies (Cachon & Harker, 2002), information sharing (Ha & Tong, 2008), risk sensitivity (Xiao & Yang, 2008), revenue sharing (Cai, Dai, & Zhou, 2012), bilateral negotiation mechanism (Feng & Lu, 2013), advertising strategy (Karray, 2015; Liu, Cai, & Tsay, 2014), and yield uncertainty (Fang & Shou, 2015). The aforementioned studies focus on either integrated or decentralized supply chain, but do not compare the different effects of these supply chain structures. Xie, Wang, and Lai (2011) study quality improvement issue under three possible channel structures in which the competing channels adopt the same selling price but compete on quality. They focus on the quality equilibrium rather than the effect of channel choice.

3. Model

Consider a setting in which one manufacturer sells a green product, whereas the other manufacturer offers a conventional product in a same consumer market. For convenience, the notations used in this paper are summarized in Table 1. Given the retail price of the green product p_g and the retail price of the conventional product p_c , the demands for the green and conventional products are given by

$$D_g = \frac{(A_g + ve) - \theta A_c - p_g + \theta p_c}{1 - \theta^2}, \quad (1)$$

and

$$D_c = \frac{A_c - \theta(A_g + ve) - p_c + \theta p_g}{1 - \theta^2}, \quad (2)$$

respectively. The larger value of the green level e indicates a more eco-friendly green product. Hence, the green product attracts more consumers given the fixed retail prices. The functions (1) and (2),

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