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Impact of structure, market share and information asymmetry on supply contracts for a single supplier multiple buyer network

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ABSTRACT

Market share of buyers and the influence of supply chain structure on the choice of supply contracts have received scant attention in the literature. This paper focuses on this gap and examines a network consisting of one supplier and two buyers under complete and partial decentralization. In the completely decentralized setting both buyers are independent of the supplier. In the partially decentralized setting the supplier and one of the buyers form a vertically integrated entity. Both buyers order from the single supplier and produce similar products to sell in the same market. The supplier charges the buyer through a contract. We investigate the influence of supply chain structure, market-share and asymmetry of information on supplier's choice of contracts. We demonstrate that both linear two-part tariff and quantity discount contract can coordinate the supply chain irrespective of the supply chain structure. By comparing profit levels of supply chain agents across different supply chain structures, we show that if a buyer possesses a minimum threshold market potential, the supplier has an incentive to collude with her. We calculate the cut-off policies for wholesale price and two-part tariff contracts by incorporating the reservation profit level of individual agents. The managerial implications of the analyses and the directions of future research are presented in the conclusion.

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1. Introduction

Many established global brands have in recent times subcontracted their manufacturing to firms in emerging countries in order to reduce costs, and have focused on design and marketing activities. However, some of the firms that supply to these global brands are also established brands themselves. Often such suppliers and buyers compete in the same end-product market; Acer, the Taiwanese manufacturer of computers and out-sourcing partner of Dell, is one such example in the electronics industry.[1] We have recently observed similar phenomenon in the smart-phone market where Samsung, the provider of the application processor, has overtaken Apple to become the market leader.[2] In spite of having the first mover advantage, Apple has lost her market position to a competitor who is also the supplier of one of the main components of the phone.[3] There are analogous examples in the pharmaceutical and textiles industries. Almost identical situation arises when a monopolist supplier enters a new demographic market modifying an existing product to meet local requirements; she needs to find a local retailer for selling of the product (Corbett, Zhou, & Tang, 2004; Li & Gupta, 2011; Xu, Shi, Ma, & Lai, 2010). Also when one firm markets her product through a 'firm-owned direct online channel as well through an independent traditional retail channel', the second independent buyer views the supplier controlled first buyer as competition (Ryan, Sun, & Zhao, 2013).

These business scenarios raise a set of questions: when one supplier is supplying to her own subsidiary and another buyer with the same raw material or end product, then how can the system be designed for achieving supply-chain coordination? Is there a possible mechanism to either reduce or eliminate conflict between the separate channels? Similar set of questions also arises if the supplier enters into a collusive agreement with an

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[1] Elizabeth Woyke, "The Company Behind Your Laptop", Forbes, 12/04/2009. Retrieved from: http://www.forbes.com/global/2009/1214/technology-wistron-simon-lin-industrial-innovator.html, accessed on 16/03/2014.

[2] John Ribeiro, "Samsung Beats Apple in Smartphone Sales", IDG News Service, 28/10/2011. Retrieved from: http://www.pcworld.com/article/242787/samsung_beats_apple_in_smartphones_sales.html, accessed on 12/03/2014.

[3] Eric Pfanner, "Why Samsung quietly cheers when Apple sells an iPhone", New York Times, 25/01/2014. Retrieved from: http://timesofindia.indiatimes.com/tech/tech-news/hardware/Why-Samsung-quietly-cheers-when-Apple-sells-an-iPhone/articleshow/29350433.cms, accessed on 11/03/2014.

independent buyer. A buyer with smaller market share would always be interested in entering into such agreement with the supplier to improve her profit level; but can such an arrangement provide the supplier with any advantage?

In this paper we attempt to answer all these questions by investigating competition between a vertically integrated firm and another firm with similar end products targeting the same market. Specifically we examine single supplier multiple buyers supply chain structure under (i) completely and partially decentralized setting, and (ii) information symmetry and asymmetry, in order to understand how the supply chain structure and the existing market share influence the design of contracts. We discuss four contract types, namely wholesale price (WP), quantity-discount (QD), linear two-part tariff (LTT), and nonlinear two-part tariff (NTT) contracts from the supplier's perspective. We compare between channel coordinating QD and LTT contracts. We find that under channel coordinating condition the supplier can either collude with an independent buyer or get into an arrangement with her sister division firm to create a win-win situation for both the firms such that they can improve their individual profit levels. In the context of WP and LTT contracts, we discuss the cut-off policies for different supply chain agents by incorporating their reservation profit levels. Finally, we numerically show how the supplier can design a preference matrix of contracts that enables her to choose contracts under different conditions of competition and market share of buyers.

The remainder of this article is organized as follows: in Section 2 we review the related literature. We describe the problem settings and formulation of quantity-discount, wholesale price, linear two-part tariff and nonlinear two-part tariff contract problems in Section 3. In Section 4, we develop the solution in terms of optimal pricing and quantity decisions under the condition of symmetric and asymmetric information for completely decentralized and partially integrated supply chains respectively. We discuss the influence of supply chain structure, market share, value of information and cut-off policies in Section 5. Finally conclusions and possible future research directions are incorporated in Section 6.

2. Literature review

Research developments in supply chain coordination through contracts aim at 'establishing business partnership and improving supply chain profits' (Chung, Talluri, & Narasimhan, 2010). Based on supply chain structure, supply chain coordination literature can be categorized as: one supplier–one buyer (1–1) (Cachon & Lariviere, 2005; Plambeck & Taylor, 2007; Taylor, 2002; Tsay & Lovejoy, 1999; Weng, 1995), one supplier–multiple buyer (1–N) (Bernstein & Federgruen, 2005; Cachon & Lariviere, 2005; Plambeck & Taylor, 2007; Weng, 1995), multiple supplier–one buyer (N–1) (Cachon & Kök, 2010; Minner, 2003), multiple supplier–multiple buyer (N–N) (Anderson & Bao, 2010; Zhao& Atkins, 2008). Cachon (2003) provides a review of all the coordinating contract mechanisms for 1–1 and 1–N supply chain structures under full information.

In the context of supply chain coordination, many studies have come out and indicated that wholesale price (Zhao, 2008), quantity discount (Cachon & Kök, 2010; Weng, 1995), and two-part tariff (Corbett et al., 2004; Zhang, Xiong, Xiong, & Yan, 2014) contracts are efficient coordinating mechanisms. Under deterministic demand scenario, wholesale pricing mechanisms coordinates a 1–N supply chain for limiting circumstances (Tsay & Agrawal, 2000). El Ouardighi and Kim (2010) have studied wholesale price contract in the presence of horizontal competition and full information. Corbett et al. (2004) have analyzed the wholesale price contract in a dyadic relationship by incorporating reservation profit level for supply chain agents and information asymmetry. Analysis of wholesale price contract in the presence of asymmetric information as well as horizontal competition is limited. Channel coordination can be obtained between one supplier and a group of homogeneous buyers through optimal quantity discount policy and franchise fee. However, the same fails to attain joint profit maximization (Weng, 1995). Corbett and De Groote (2000) have analyzed the quantity discount contract in a dyadic relationship between supplier and buyer under asymmetric information and derive the optimal discount scheme. Competition between buyers is not considered in their work. Cachon and Kök (2010) discuss quantity discount contract in the presence of horizontal competition and full information availability. However, none of the aforementioned work analyses either wholesale price or quantity discount contract for a partially decentralized supply chain.

Two-part contracts provide us with the first-best optimal solution that can overcome the problem of double marginalization in bilateral monopoly with full information (Tirole, 1988). How two-part tariff type contracts help in coordinating a supply chain has been studied by Jeuland and Shugan (1983). Weng (1995), has extended their work in terms of determining optimal pricing policies that can coordinate the channel's activities. Corbett et al. (2004) have shown that by employing two-part tariff contract the supplier can not only coordinate the supply chain but also extract the entire profit from the buyer in presence of full information. They also show a non-linear two-part tariff helps in designing a menu of contract such that the buyer reveals her cost structure in the case of asymmetric information. However, their study is limited by the dyadic relationship. Xie, Jiang, Zhao, and Shao (2014) have analyzed two-part tariff contracts in the context of a product service system and Zhang et al. (2014) have analyzed linear and nonlinear two-part tariff contracts in the context of closed loop supply chain. The analysis of two-part tariff contracts in the presence of horizontal competition has got little or no attention.

Market share or the underlying market potential of the buyer and the influence of various supply chain structures on the choice of optimal contracts have received scant attention. Most of the single supplier multiple retailer supply chain literature focuses on the question of whether it is beneficial for a supplier to add a direct online channel (Bernstein & Federgruen, 2005; Cachon & Lariviere, 2005; Plambeck & Taylor, 2007; Zhao & Atkins, 2008). In real life, we often observe apparel industry selling the same product through own franchise network as well as through other retail stores. The channel consisting of the supplier and the independent buyer faces the classic double marginalization problem. The supplier-owned buyer faces horizontal price competition with the independent one, similar to the case described by Tsay and Agarwal (2000). The supplier further faces vertical price competition with the second buyer. Ryan et al. (2013) has looked into such aspects of supply chain coordination when manufacturer has chosen to take a dual-channel approach to distribute her product. However, they do not consider the case of asymmetric information between the supplier and the second buyer.

Since firms are increasingly adopting multiple channel approach for distribution, one supplier–multiple buyer supply chain structure has been studied extensively in recent times (Farahani, Rezapour, Drezner, & Fallah, 2014; Rezapour, 2010). In the presence of horizontal competition among buyers, market share plays an important role in the optimal pricing and quantity decisions (Coughlan, 1985; Ingene & Pappy, 2004). Anderson and Bao (2010) have explored the effect of horizontal price competition and market share on decentralized supply chain. Their work does not throw any insight into how the aspect of market share influences optimal contract decisions. The literature on the effect of market share and the change of supply chain structure in the presence of asymmetric information is also limited.

In this paper, we analyze two general contract types, namely quantity discount and nonlinear two-part tariff, and their specific