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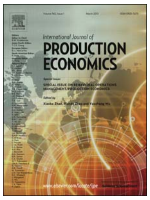

Equilibrium evolution in a two-echelon supply chain with financially constrained retailers: The impact of equity financing

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ABSTRACT

This paper considers a two-echelon supply chain that has a supplier and two capital constrained retailers and in which the retailers compete in a Cournot fashion. We study the impact of external financing on the players' optimal decisions and supply chain performance. We show that as competition intensity increases, the supplier (as the Stackelberg leader) may consider merging with one retailer to avoid double marginalization. Yet, the deselected retailer may utilize external financing to return to the supply chain. We explicitly model the evolution of equilibrium scenarios and identify the conditions under which the supplier may prefer to provide trade credit to only one retailer and the other retailer may use external financing. We also carry out extensive sensitivity analyses with respect to a retailer's capital structure and the retailer's competition intensity.

1. Introduction

One of the most important decisions that capital constrained retailers face is how to finance their operations. In response to the retailers' financial constraints, many manufacturers extend trade credit to their buyers so that retail channels can maintain sustainable operations. Through this credit, buyers can delay their payments until the products are sold. Trade credit has become one of the most popular financing mechanisms in today's business practices. For example, over 80% of B2B transactions in the UK are made on trade credit. Furthermore, in the US, approximately 80% of firms offer their products on trade credit (Seifert et al., 2013). A supplier endowed with sufficient capital provides trade credit to help retailers stay in business and achieve a win-win situation (Goyal, 1985; Huang, 2007; Teng et al., 2012; Taleizadeh et al.,2013). Indeed, many scholars have shown that all channel members may benefit from the use of trade credit, as opposed to the use of bank loans, to finance capital constrained retailers (Jing et al., 2012; Jing and Seidmann, 2014; Yang et al., 2014; Du et al., 2013; Kouvelis and Zhao, 2012).

Research has shown that in a one-to-many supply chain with a supplier and multiple retailers, each player becomes worse off when the competition between retailers is intensified (Yang and Zhou, 2006; Wu et al., 2012). As a consequence, manufacturers may strategically streamline their retail channels by cooperating with a single retailer. This implies that other retailers may drop out of business. Glock and Kim (2015) study such a supply chain and confirm that some retailers may be deselected by the vendor. Yang and Zhou (2006) study the effect of retailers' competitive paradigms on each player's equilibrium behavior. They find that if two retailers collude, all of the supply chain members make more profits. The collusion between retailers is essentially equivalent to the case in which a single retailer exists. Thus, the above result implies that manufacturer can benefit from merging with a single retailer. In addition, numerous studies concerning competition between supplier and retailer interaction in a supply chain have been conducted. Li et al. (2015) shed light on issues regarding conflict between two heterogeneous channels and vertical competition. Wang et al. (2016) establish a linear demand model to explore the channel selection and pricing strategy in a supply chain comprising a dominant multi-channel retailer and a manufacturer. In addition, the retailer is the leader of pricing in the supply chain.

Notably, the above findings build on an important assumption: each player has sufficient capital to support its various business decisions. As discussed earlier, however, many firms suffer from capital shortage. In this paper, we are particularly interested in the situation in which retailers have capital constraints and may receive trade credit from their supplier. For example, through our interaction with Telstra, the largest communication service provider in Australia, we find that many retail outlets that sell their mobile devices and service plans are small buyers and have very limited financial capacity. Because the sales of these small retail outlets account for a large portion of total sales, Telstra must provide these retailers with trade credit.

Some literature has established that in a one-to-one supply chain,

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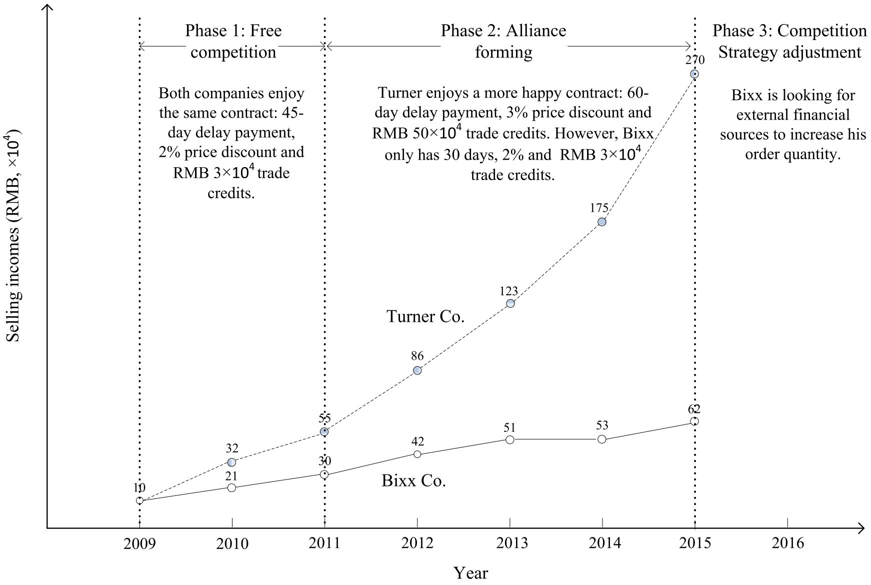

Data source: Turner Co.'s market analysis report.

Fig. 1. Revenue growth of Turner Co. and Bixx Co. from 2009 to 2015 (data obtained from a market analysis report provided by the CEO of Turner Co.).

the coordination between the supplier and the capital constrained retailer can overcome the double marginalization effect and improve the profits of the overall supply chain and individual firms (Spengler, 1950; Cachon, 2003; Ru and Wang, 2010). Lee and Rhee (2011) show that full coordination can be achieved when a supplier properly designs the trade credit and buyback contract. Chen (2015) shows that a capital constrained retailer makes more profit in a centralized supply chain than in a decentralized supply chain. Feng et al. (2015) investigate the supply chain coordination problem under three contract forms, including revenue sharing, buy back and revenue-sharing-and-buy-back contracts, when both the supplier and the retailer are subject to capital constraint. They show that the revenue sharing and buy back contracts are ineffective under certain budget scenarios, whereas the revenue-sharing-and-buy-back contract can always coordinate the supply chain and arbitrarily divide the total profit among players (Lee and Rhee, 2010; Yan and Sun, 2013; Xu et al., 2015; Zhang et al., 2014; Jin et al., 2015).

Although many papers have documented the benefit of the merger of a supplier and a single (financially constrained) retailer, other retailers may still have opportunities to join the supply chain. In practice, other external financing options, such as equity financing, are available to these retailers. The retailer that drops out of the supply chain can use equity financing to resolve capital constraints so that it can still return to the supply chain. Brander and Lewis (1986) use a duopoly model to study the impact of firms' capital structure on ordering decisions. They indicate that firms with greater debt tend to be more aggressive, an effect termed as "the limited liability effect". In equilibrium, such firms have strategic advantages in the competitive market. To extend these findings, Brander and Lewis (1988) incorporate bankruptcy costs into the competition model and focus on the effect of debt levels on firms' equilibrium behaviors.

In this paper, we consider a two-echelon supply chain that has a supplier and two capital constrained retailers and in which the retailers engage in quantity competition. The supplier, as a leader in the Stackelberg game, can provide trade credit to the capital constrained retailers. Several papers employing a similar setup without capital constraints have shown that as competition intensity increases, each player's profit decreases (Yang and Zhou, 2006; Fang and Shou, 2015). As the Stackelberg leader, the supplier may find it beneficial to merge with one retailer to avoid double marginalization. In this case, the supplier provides trade credit to only one retailer, and the other retailer is not financed. If no external financing source is available, this retailer will eventually drop out of the supply chain. However, as mentioned earlier, the retailer may have access to equity financing or bank financing (i.e., debt financing). This poses an interesting question: In the presence of external financing, can the abandoned retailer rejoin the supply chain? In other worlds, what is the impact of external financing on supply chain performance as a whole and on each player's profit? Several papers have studied the effect of bank financing on operational performance in a one-to-one supply chain. When a financially constrained retailer uses bank loans, the supply chain's efficiency cannot be improved; thus, coordination cannot be fully achieved (Kouvelis and Zhao, 2012; Chen, 2015).

Our paper is distinct in that it considers a competitive setting in which downstream retailers are subject to financial constraints. The supplier provides trade credit to one or two retailers, and the retailer endowed with no support from the supplier may seek finance from investors and/or banks. With this setup, we consider three cases: in Case 1, the supplier provides trade credit to both retailers; in Case 2, the supplier provides trade credit to only one retailer and the other retailer has no other financing options; and in Case 3, the supplier provides trade credit to one retailer but the other retailer is able to use external financing, including equity financing and debt financing.

Through our discussions with an SME firm in China, we observe the evolution of a pattern of competition similar to that in the above three cases. Turner Co. and Bixx Co. both sell art material products in China. They began to sell Canson branded products supplied by Arjowiggins Co. in 2009. Fig. 1 depicts the revenues of the two companies from 2009 to 2015. The figure shows scenarios that are similar to those considered in this paper. During 2009–2011, both companies were offered the same contract involving a 45-d delay payment, 2% price discount and RMB 30,000 trade credits. The two companies enjoyed a similar profit rate of approximately 25% during that period. This phase of competition resembles Case 1, in which retailers engage in free competition. Thanks to proactive market exploration, after 2011, Turner Co. had significantly increased its sales. To compensate Turner Co., the supplier started to offer the retailer a better contract with a 60-d delay payment, 3% discount and RMB 500,000 trade credits. By contrast, Bixx Co. was offered an even worse contract than that it previously had, with only a 30-d delay payment. As a result, in 2015, the profit of Turner Co. grew to RMB 2,700,000, which is equivalent to the profit rate of 29%. By contrast, Bixx Co. maintained

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