



The value of partnership under competition: When competitors may be R&D joint-venture and supply-chain partners for a critical component



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ABSTRACT

Conventional wisdom suggests that firms are worse off when the intensity of competition increases. However, when competitors have the option of cooperating as supply-chain and R&D joint venture (RJV) partners, the findings may be counterintuitive. In this paper, we consider two competing firms that must develop a critical component for their products. They must decide whether to develop a distinct component or to form an RJV with their competitor in order to develop a common component, and how much research effort should be exerted to improve the quality of this component. Forming an RJV partnership reduces R&D investment because both firms are jointly responsible for the research cost, but customers perceive the products to be less differentiated, thus leading to a more intense degree of competition between products. Moreover, one of the manufacturers does not produce this component and must therefore decide whether to outsource the production of this component to its competitor or to a third-party supplier. We examine the following two drivers of competition: (1) competition because the two base products are substitutable and (2) when the two firms form an RJV to develop a common component, the competition between these two products intensifies. Our main results show that both firms are better off when the competitiveness of the industry increases or when forming an RJV intensifies the competition between two products. Moreover, we investigate the robustness of our results to the firms' bargaining powers by considering a generalized Nash bargaining game where firms negotiate on the RJV partnership decision, and we find that unless the supplier has a very large bargaining power, our results hold.

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1. Introduction

The Korean consumer electronics manufacturer LG Corp. developed a high-resolution, five-inch display for its smartphone. When compared to the retina display of an iPhone 4S, which has 330 ppi (pixels per inch), this new LG screen, with 440 ppi, constitutes a better display. However, Apple has remained unimpressed by LG's new advancement because it has developed a new display of its own that uses in-cell technology, which can rival LG's display. Interestingly, Apple has outsourced the production of this new display to LG (Ionescu, 2012).

A component can have a non-trivial impact to the success of a product. Despite the importance of the component, firms sometimes rely on their competitors to serve as their component suppliers. For example, Apple and Taiwanese smartphone manufacturer HTC purchase computer chips from Samsung. Palm (now

owned by HP) sells handheld devices to customers directly and also supplies its operating system to HP and Dell's handheld devices (Venkatesh et al., 2006; Xu et al., 2010).

Many considerations come into play when outsourcing to a competitor. Since both competing products require the critical component, one of the main decisions concerns whether or not to form an R&D joint venture (RJV) with the competing manufacturer to develop the common component. RJVs between competing manufacturers have become a common practice in the industry, as joint research efforts avoid duplication of R&D activities and allow learning through sharing of knowledge, in turn reducing R&D costs through shared investment.

Since the use of distinct components constitutes an important way for firms to differentiate their products, forming an RJV to develop a common component thus comes at a cost, since customers may perceive the products to be less differentiated. Robertson and Ulrich (1993) found that the instrument panels for two different car models lost distinctiveness when the two models used a common component, resulting in greater competition between these two models. In addition, BMW was concerned about

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less differentiation with products from DaimlerChrysler AG and General Motors when forming an RJV with these two firms to jointly develop a two-mode hybrid drive system (Bourreau and Doğan, 2010). Consequently, as forming an RJV may not always be beneficial for the competition, in some cases, even when competing firms are supply-chain partners, in order to develop distinct components, they may choose to perform their R&D activities separately.¹

In this paper, we consider a system that consists of two firms selling competing products, and each firm must develop a critical component for its own products. These two firms must decide how much quality-improvement research effort should be invested, and whether to perform individual research to develop distinct components or to form an RJV with their competitors to develop a common component. When the two firms form an RJV partnership, they are jointly responsible for the research cost, so the R&D investment to reach a specific quality level is smaller when compared to performing individual research to acquire the same quality. However, this partnership comes at a cost since customers then perceive the products to be less differentiated, leading to a more intense competition between products. Furthermore, one of the firms does not produce this component in-house and must also decide whether to outsource the production of the component to its competitor or to a third-party supplier. Our paper focuses on how the following two drivers of competition affect the firms' profits. First, the products compete because they are substitutable. Second, when the firms form an RJV to develop a common component, customers perceive the products to be less differentiated, which in turn intensifies the competition between these two products.

- Would the firms' R&D investments and prices be larger under RJV partnership or under supply-chain partnership?
- Would the firms have a higher profit under RJV partnership or under supply-chain partnership?
- How are the competitors' profitabilities affected when competition between the two substitutable products intensifies?

When comparing between the nature of cooperation (RJV versus supply-chain), we find that prices can be higher (and, hence, price competition is mitigated) under an RJV partnership, but a supply-chain relationship is always more valuable to the supplier while an RJV partnership is more valuable to the outsourcer, regardless of how much the formation of an RJV partnership intensifies competition. Furthermore, one might expect that when the competitiveness of the industry increases, or when forming an RJV would have an increased impact on the competition between products, both firms would be worse off. Interestingly, our results show that both firms are always (weakly) better off when the industry becomes more competitive or when cooperating as RJVs to develop a common component intensifies competition. We also consider a scenario where the firms negotiate the contract via a generalized Nash bargaining scheme to examine the robustness of our results. We find that regardless of the degree of bargaining power, both firms are (weakly) better off when the formation of an RJV partnership intensifies competition. Moreover, unless the supplier has a large bargaining power, both firms are better off when the industry becomes more competitive.

This paper is structured as follows. In the next section, we review the related literature. Then the mathematical model and the analytical results are presented in Sections 3 and 4. In Section 5,

¹ It is possible to use a distinct component, even though the two firms are supply-chain partners. For example, the firm can patent the component such that its competitor cannot use it for its own product, just as Apple has done for its display technology.

we consider several extensions to the main mathematical model. Finally, in Section 6, we conclude the paper. Appendices A and B show the details of the derivation of the equilibriums and the proofs of the results.

2. Literature review

One of the main features of our paper addresses the fact that manufacturers and their suppliers have conflicting incentives, so these firms incur a transaction cost when manipulating each other's conflicting incentives (e.g., Williamson, 1979, 1985; Williamson and Ghani, 2012). We also study the differences between supply-chain partnership and R&D partnership, which aligns our paper with the branch of literature that examines different types of cooperation between firms (e.g., Contractor, 1985; Contractor and Lorange, 1988). Specifically, using data from international hotel businesses and the global pharmaceutical sector, Contractor and Kundu (1998) and Contractor et al. (2011) examine the optimal choice of partnership between firms and the impact of direct and indirect technology commonality. Our paper also relates to literature on quality control, in which the manufacturer must manage the incentive of its supplier in order to obtain a high-quality product (e.g., Tse and Tan, 2012; DeYong and Pun, 2015; Pun and Heese, 2015).

Since we examine a case where the manufacturer needs to decide whether to outsource to a third-party supplier or to its competitor, another relevant branch of research is on the topic of supplier selection. Koufteros et al. (2012) consider the supplier selection decision using the resource-based framework. They focus on how the supplier's quality capability and cost capability affect the buyer's performance capability, and they show that strategic supplier selection and the nature of the resources selected are among the buyer's most important decisions. This also leads to the literature that examines the scenario of a firm acting as a supply chain partner with its competitor. Venkatesh et al. (2006) and Xu et al. (2010) study the supply chain structure decision for a proprietary component manufacturer. This manufacturer can choose to provide its component to a competing manufacturer, exclusively develop the product, or supply the component to the competing manufacturer and sell the product under its own brand. Wang et al. (2013) investigate the advantage of being the first mover when a contract manufacturer acts as both supplier and competitor. Furthermore, Pun (2014) and Pun (2015) examine two competing firms that can either outsource to one another or to a third-party supplier, and they find that more cooperation between competing firms can be harmful. However, this stream of related literature does not consider the impact of increasing competition when using a common component, and it does not study the firm's RJV decision with the competitor.

Our paper also relates to the stream of literature that shows how component-sharing increases the substitutability (and reduces differentiation) of different products (e.g., Desai et al., 2001; Heese and Swaminathan, 2006), but these authors assume that the products are produced by the same firm and therefore do not consider competition between firms. Another related literature stream focuses on the firm's decision to enter into an R&D joint-venture with a competitor (e.g., Anbarci et al., 2002; Lambertini et al., 2002; Bourreau and Doğan, 2010), but these papers assume that the firms are not supply chain partners. We reveal some counterintuitive findings when considering the decision of whether or not to form an RJV with a supply chain partner who has a competing product.

Our paper concerns firms innovating for a new critical component, so another stream of relevant literature is on the topic of new product development (NPD). Using more than 100 data from

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