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Capacity allocation under downstream competition and bargaining

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ABSTRACT

In this study, we consider a monopolistic supplier's capacity-allocation problem under bargaining. The supplier can allocate one type of key element to either an external channel with a manufacturer, an internal channel, or both. The firms use the element to produce substitutable final products and compete in the product market. By building a stylized model, we characterize the equilibrium decisions under different channel choices. The conditions of the equilibrium channel choices are derived. We find that the supplier's shared capacity increases with his bargaining power, but the manufacturer's shared capacity *decreases* with her bargaining power. Meanwhile, the higher bargaining power may *backfire* on the manufacturer, because her loss from a decreased shared capacity may dominate her benefit from an increase in her bargaining power.

Under the dual channel, as market competition intensifies, the high-cost firm's shared capacity always decreases; however, the low-cost firm's shared capacity decreases and increases sequentially if the manufacturer's bargaining power is sufficiently small, and increases if her bargaining power is sufficiently large. The reason is that the low-cost firm's competitive advantage relative to the high-cost firm is amplified by the manufacturer's increased bargaining power. Either firm's production cost improvement can *benefit* the other. If the firms' demand functions are asymmetric, an increased customer valuation on the manufacturer's products *benefits* the supplier; an increased price sensitivity to demand on the supplier's products may *harm* the manufacturer. Moreover, when the supplier sells to two manufacturers, one manufacturer can *gain from* an increase in the competing manufacturer's bargaining power.

1. Introduction

Samsung Electronics not only supplies microprocessor to Apple Inc. for its iPhone, but also sells the Galaxy S phone and competes with Apple Inc. in the smartphone market. The coexistence of vertical (supplier and manufacturer) and horizontal (competing manufacturers) relationships is quite common in many other industries. For example, many gasoline refiners sell key inputs to downstream competitors (Arya, Mittendorf, & Sappington, 2008); telecommunication companies often purchase or rent networks from their market competitors (Weisman & Kang, 2001); railway companies frequently sell track right to their competitors (Sappington, 2005). Coexistent vertical and horizontal relationships also prevail in the retail supply chain (Rodríguez & Aydın, 2015). For instance, Ralph Lauren not only operates company stores but also sells products via independent retailers such as Macy's (Bell, Wang, & Padmanabhan, 2003); Nike Inc. sells shoes at independent retailers and its own online stores simultaneously (Hsiao & Chen, 2014).

All the aforementioned examples involve partial forward integration in which the supplier sells only a portion of the element (raw material or other resources) to external buyers and uses the rest internally. Generally, the issue of whether to adopt partial forward integration forms part of an enterprise's strategic decision-making. The impact of the decision is huge as it involves considerable costs of channel duplication, such as long-term infrastructure investment on production capacity, or on new store/online sales platform building in the retail setting.

As a specific form of dual channel, partial forward integration usually requires the existing element capacity to be allocated appropriately between different downstream channels. The reason is twofold. First, capacity building or expansion in many industries is very costly and time consuming (e.g. communication network), or capacity is constrained exogenously (e.g. some natural resources).

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Second, capacity allocation affects the firms' shares of product market, their profits, and total supply chain efficiency.

Despite the importance of optimal capacity allocation under partial forward integration, it has been understudied in the research literature. The capacity-allocation literature generally assumes that the supplier allocates all capacity to independent downstream buyers that are local market monopolists (e.g. Cachon & Lariviere, 1999a; 1999b; Chen, Deng, & Huang, 2014) or market competitors (e.g. Liu, 2012). Meanwhile, the literature on partial forward integration focuses on extensive research topics, like vertical foreclosure (e.g. Sappington, 2005), channel control (Chiang, Chhajed, & Hess, 2003), and strategic investments (e.g. Arya & Mittendorf, 2013). However, these studies usually presume unlimited capacity for the supplier and do not consider the capacity-allocation problem.

Intuitively, how a supplier allocates his capacity between the two channels may relate to the degree of substitution between the final products of the supplier and buyers (or the degree of market competition) and their product production costs (or marketing costs in the retail setting). It is well established that the degree of product substitution and cost are important factors that influence the channel structure decision and competing firms' market shares (e.g. Arya, Mittendorf, & Sappington, 2007; Bhardwaj, 2001; Ha, Tong, & Zhang, 2011; McGuire & Staelin, 1983; Shaked & Sutton, 1982).

In addition, the supplier's optimal capacity-allocation decision under market competition is linked to the firms' bargaining powers. Some studies find that bargaining power significantly influences the firms' market competition behavior in supply chains (e.g. Feng and Lu, 2012; 2013; Guo & Iyer, 2013). Intuitively, bargaining is a common path of price realization and profit allocation when each party possesses some bargaining power (e.g. Samsung and Apple, Ralph Lauren, and Macy's), and has been applied extensively in various research fields, such as economics (e.g. Milliou & Petrakis, 2007), marketing (e.g. Symeonidis, 2008), and supply chain management (e.g. Feng & Lu, 2012; 2013).

Building on the abovementioned studies, we seek to understand how a supplier makes optimal capacity-allocation decisions in the presence of bargaining. In particular, we seek to understand the following questions. In what situations should the supplier chooses the dual channel or a single channel (the exclusive external or internal channel)? How much capacity should be allocated to each channel if the dual channel is selected? What are the impacts of some key factors (e.g. the degree of product substitution, bargaining power, and production cost) on the optimal capacity-allocation decisions? Managers of the supplier would like to know the answers to these questions.

To answer these questions, we construct a stylized model in which a supplier intends to sell one type of key element to a manufacturer for producing the final product. Other than external supply, the supplier can also internally use the element to make a substitutable product and compete with the manufacturer in the market. The supplier has the authority to allocate the existing element capacity between the internal and external channels once the capacity is set up. The element price is negotiated based on the two firms' bargaining powers. Different cases are considered. In the base case, the element capacity at the beginning can be selected without constraint, the firms' bargaining powers are given exogenously, and their demand functions are symmetric. In the extended cases, we further incorporate the constrained element capacity, asymmetric demand functions, and multiple manufacturers, respectively.

In the base case, we characterize the equilibrium decisions under the dual channel, exclusive external channel, and exclusive internal channel. The conditions of the equilibrium channel choices are derived. It is found that the supplier's shared capacity increases with his bargaining power, but the manufacturer's shared capacity *decreases* with her bargaining power. This outcome is because when the manufacturer becomes more powerful, or when the supplier becomes less powerful, the supplier is incentive to offset the negative effect of a decreased negotiated element price by allocating less capacity to both firms. We find that the supplier's profit always decreases with his bargaining power. However, the manufacturer's profit could *decrease* with her bargaining power when she is sufficiently powerful; thus, higher bargaining power may *backfire* on the manufacturer. The reason is that as the manufacturer becomes more powerful, the negative impact of a decrease in her shared capacity dominates the positive effect of an increase in her bargaining power on her profit. The literature usually deems that a key resource supplier is highly powerful and thus, his buyer is in a disadvantageous position (e.g. Porter, 2008; 1980). However, we argue that, in order to achieve a higher profit, the buyer may prefer the supplier to be more powerful.

It is also found that the high-cost firm's shared capacity always decreases as market competition intensifies. However, more intensified market competition causes the low-cost firm's shared capacity to first decrease and then increase if the manufacturer's bargaining power is sufficiently small, and to increase if the manufacturer's bargaining power is sufficiently large. This result is because an increase in the manufacturer's bargaining power amplifies the low-cost firm's relative competitive edge in capacity sharing when competition intensifies, regardless of whether the low-cost firm is the manufacturer or supplier. Thus, the impacts of market competition and bargaining power on capacity allocation are *intertwined*.

We discover that either the supplier's or the manufacturer's production cost improvement can *benefit* the other firm; this result may provide an explanation for the prevalent phenomena that firms help improve their competitors' production efficiency in the context of the dual channel. Meanwhile, the supplier's production cost improvement can *increase* the manufacturer's shared capacity under the exclusive external channel. In the extended cases, we find that the optimal allocation is *independent* of the firms' bargaining powers if the element capacity is sufficiently scarce. Given the firms' asymmetric demand functions, the supplier *benefits* from an increased customer valuation on the manufacturer's products, and the manufacturer may be *harmed* by an increased sensitivity of price to demand on the supplier's products. When the supplier sells to two manufacturers, one manufacturer's profit may *increase* with the other manufacturer's bargaining power if the degree of market competition is relatively high.

The rest of this study is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces our model setting. Section 4 characterizes the equilibrium channel choices and capacity-allocation decisions and analyses the impacts of key factors. Section 5 discusses related extensions. Section 6 provides concluding remarks. All proofs are in the appendices.

2. Related literature

There has been a growing body of literature on capacity allocation in the field of operations management (e.g. (Chen, Li, & Zhang, 2013; Feng, Li, & Shen, 2015b; Li, Cai, & Liu, 2016; Liu, 2012; Roels & Tang, 2016; Schuetz & Kolisch, 2012; Vernik & Purohit, 2014; Zhou, Geng, Jiang, & Wang, 2017)). Generally, in a capacity-allocation setting, a monopolistic supplier allocates existing capacity to multiple buyers under certain mechanisms (e.g. Cachon & Lariviere, 1999a; 1999b). Most research assumes that the downstream buyers are local monopolists and do not compete with each other in the product market (e.g. Cachon & Lariviere, 1999b; Chen et al., 2014; Chen, Su, & Zhao, 2012b; Feng, Li, & Shen, 2015a; Lu & Lariviere, 2012; Vernik & Purohit, 2014). A few studies consider that downstream buyers compete for customer

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