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Three strategies for engaging a buyer in supplier development efforts

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ABSTRACT

The effectiveness of supplier development programs has resulted in a wide range of applications in various industries. By emphasizing on cooperative efforts of suppliers and buyers, these programs can significantly improve the suppliers' performance. This leads the suppliers to develop different strategies that increase the involvement of their buyers. In this study, we identify three strategies that a supplier can implement to facilitate the supplier development effort of its buyer: (1) wholesale price manipulation, (2) paying a share of investment, and (3) controlling the investment. We analyze the implementation of these strategies under uncertainties of supply and demand to expand the applicability of the models and results. In this study, we show that the optimal decisions of the players under all three strategies are unique. Our findings also indicate that the effectiveness of these strategies decreases as the profit margin of the buyer increases. In addition, we explore the effect of profit margins and demand uncertainty on the players' optimal decisions. Through numerical analysis, we indicate that for low buyer's and supplier's profit margins, the supplier prefers wholesale price manipulation strategy. On the other hand, when the profit margin of the supplier is relatively high, paying a share of investment strategy is more attractive. Moreover, our results demonstrate that uncertainties of supply and demand may have contradictory effects on players' optimal decisions.

1. Introduction

In many industries, supply chain management is viewed as one of the main sources of competitive advantage (Handfield et al., 2006). Accordingly, many companies pursue different approaches to ensure high performance of their suppliers. One possible approach is adopting supplier development programs (Wagner, 2006b). Krause et al. (2007) defined supplier development program as any direct and indirect attempt of a buyer to enhance the performance and efficiency of a supplier. These programs are aimed at improving product quality, lowering supply chain cost and enhancing profitability for supply chain members. The effectiveness of supplier development programs has been demonstrated by several studies, and it is indicated that they are a source of competitive advantage for buying firms (Humphreys et al., 2004; Dalvi and Kant, 2018; Kumar et al., 2018). Today, organizations have realized the importance of these programs and industry leaders have widely applied them in their supply chains (e.g. Ikea (Rana, 2016), IBM, Walmart (Routroy and Pradhan, 2014), Delphi (Zhang et al., 2015), and GM (Bai and Sarkis, 2016)).

In supplier development programs, a buyer may implement different strategies, such as enforced competition, informal assessment, and knowledge transfer to enhance the performance of a supplier (Krause and Ellram, 1997; Dyer, 1996; Modi and Mabert, 2007). In general, these strategies can be classified into “direct” and “indirect” activities (Krause et al., 2000; Wagner, 2006b, 2010). Direct supplier development comprises allocation of capital, human resources, and equipment to suppliers, while in indirect activities, the buyer allocates no or just limited resources to the improvement of supplier's operations. (Wagner, 2006b). The literature has shed light on differences between direct and indirect supplier development activities and suggestions have been provided on when and in what capacity each category should be implemented (e.g. Wagner (2010)). When suppliers suffer from lack of knowledge, technology, or financial capital, they may be more responsive to direct supplier development (Krause et al., 2000). Accordingly, in this study we focus on the case in which the buyer implements direct supplier development activities to enhance the supplier's performance.

Direct supplier development activities can substantially improve the

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performance of suppliers. (Krause et al., 2007). These improvements include but not limited to enhancements in supplier's capability (Bai and Sarkis, 2011), capacity (Chao et al., 2009), profit (Li et al., 2016b), product quality (McGovern and Hicks, 2006), production cost, delivery time (Krause et al., 2007), and managing uncertainty (Liker and Choi, 2004). Therefore, many suppliers prefer to collaborate with buyers that implement such strategies. For instance, the study of Liker and Choi (2004) revealed that component buyers in auto-industry prefer to work with companies, such as Toyota and Honda, that use direct involvement in supplier development. Considering various benefits of direct supplier development programs on suppliers' performance, it is reasonable for strategic suppliers to motivate their buyers to commit more in these programs (Webb, 2018). However, a quick glance at the pertinent literature reveals that most of the studies in this area are buyer oriented and have considered a reactive role for suppliers (Dalvi and Kant, 2015; Sillanpää et al., 2015; Glock et al., 2017), despite the importance of supplier's perspective in any buyer-supplier collaborative relationship (Nyaga et al., 2010). In order to fill this gap, in this study, we investigate direct supplier development programs with an emphasis on supplier. Hence, our research question in this study is: *"How suppliers can attract buyers' resources in direct supplier development?"*

We focus on the relationship of a buyer (she) and a supplier (he) under supplier development programs. We suggest three strategies, Wholesale Price Manipulation (WPM), Paying a Share of Investment (PSI), and Controlling the Investment (CI), that the supplier can implement to increase the involvement of the buyer in supplier development activities. In order to analyze the behaviours of the buyer and the supplier, we adopt Stackelberg game setting to capture the sequential nature of players' decisions. This setting has been widely used in the literature to capture the dynamic nature of supplier development programs (e.g. Taylor and Plambeck, 2007; Tang et al., 2014; Li et al., 2016a; b). In this paper, we investigate the problem under complete information setting as the buyer is directly involved in the supplier development activities. Therefore, it is reasonable to assume that the buyer has thorough knowledge about the supplier's operation.

Uncertainty is an inevitable element of any process in a supply chain (Lavastre et al., 2014) and uncertainty of supply is one of the main sources of risk (Wagner and Bode, 2008). Several studies have revealed that ignoring supply chain risks, specifically supply risk, can have detrimental effect on the performance of supply chain (Wagner and Bode, 2008; Heckmann et al., 2015). Uncertain capacity is one of the main ways to model supply uncertainty and it can encompass a wide range of random phenomena in production systems, such as machine breakdowns, unscheduled maintenances, unavailability of human resources, defect products, and minor disruptions (Ciarallo et al., 1994). Consequently, we adopt uncertainty of capacity in our models to analyze supply risk. The supplier's capacity uncertainty can directly affect the buyer's operations and can be considered as a source of risk. Hence, the buyer can implement supplier development programs to alleviate this risk. In our study, we focus on the case where supplier development programs are targeted at improving the supplier's reliability and capacity.

Our results show that under all strategies, the optimal decisions of the buyer and the supplier are unique. The effect of wholesale price manipulation and paying a share of investment strategies diminishes as the buyer's profit margin increases. In addition, we show that when players share the development costs, the players' profit may not have a positive relation with their profit margins. Using numerical analysis, we demonstrate that the uncertainties of supply and demand may not have a similar effect on the buyer's and supplier's decisions. While an increase in the uncertainty of demand may reduce the investment, an increase in uncertainty of supply may have a reverse impact.

Our contribution to the field of supplier development in this study is twofold:

1. All the studies in direct supplier development are buyer oriented and have considered a reactive role for suppliers. It is very well-established that direct supplier development activities can substantially enhance suppliers' performance (Krause et al., 2000, 2007; Wagner, 2010). Hence, it is essential for suppliers to develop strategies that facilitate supplier development activities of their buyers. In this study, by using mathematical programming, we aim to shed light on some of the strategies that suppliers can implement to attract buyer's direct investment in supplier development activities.
2. A very limited number of researches have studied the cooperation of a buyer and a supplier in improvement of supplier's production capacity and reliability under uncertainties of supply and demand (e.g. Tang et al. (2014); Li et al. (2016a, b); Bai and Sarkis (2016)). All these studies focused on a very specific capacity or reliability improvement function. Our study considers a relatively more general function for supplier's endogenous capacity and extends the current literature in cooperative direct supplier development under uncertainties of supply and demand.

The rest of the paper is organized as follows: in Section 2, we review the most relevant literature. Section 3 provides the description of the problem. Section 4 is devoted to the wholesale price manipulation strategy. We analyze the paying a share of investment and controlling investment strategies in Sections 5 and 6. Finally, the problem is analyzed numerically in Section 7 and the managerial implications and future research is provided in Section 8.

2. Literature review

Supplier development programs have a long history of application in different industries; nonetheless, their extensive implementation can be traced back to the past two decades (Hines, 1994). In alignment with industry, the number of publications in this area has significantly increased in the past few years (Dalvi and Kant, 2015; Sillanpää et al., 2015). Several studies have investigated the impact of direct and indirect supplier development activities on the performance of buyers and supply chains (Noshad and Awasthi, 2018; Wuttke et al., 2018; Routroy and Pradhan, 2013). It has been demonstrated that under some conditions, suppliers are more responsive to direct supplier development activities. For instance, Krause et al. (2000) studied the adoption of supplier development programs by an electric company and they found that due to the lack of resources, suppliers were more responsive to direct supplier development. In such cases, the contribution of buyers and adopting direct supplier development activities can have a significant impact on supply chain. A similar situation has been found in various industries such as aerospace (Parker and Shotter, 2012; Broderick, 2015) and pharmaceutical industries (Page, 2017). Hence, various companies have implemented direct supplier development programs to enhance their supply chains. For instance, Toyota helps its suppliers to implement Toyota Production System (TPS) (Bai and Sarkis, 2016); Samsung partially funds the development projects proposed by its suppliers (Jeon, 2012); BMW and Hyundai send their engineers to their suppliers' facilities to improve their production systems (Handfield et al., 2006). In some cases, engineers may stay for several months in suppliers' facilities to ensure their competencies. This strategy may impose a significant cost to the buyer; nevertheless, it can improve the performance of suppliers significantly. In fact, a study by De Toni and Nassimbeni (2000) showed that better performing companies put more emphasis on direct supplier development. Based on the scope of this study, here we review the papers that have an emphasis on direct supplier development activities.

A large portion of the pertinent literature is devoted to evaluating direct supplier development activities through empirical analysis and case studies (Ahmed and Hendry, 2012). There is a stream of research in the literature which focused on analyzing the relationship between direct supplier development activities and different performance measurements. A multitude of studies has indicated that these activities