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Services outsourcing under asymmetric cost information

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ABSTRACT

In this paper, we investigate the impact of cost heterogeneity on the optimal sourcing strategy of a client firm that outsources her service requirements to a set of outside vendors/service providers. We analyze a typical situation involving service providers, who differ from one another with respect to the marginal cost and characterize the firm's optimal size of vendor network. In our model, the client firm does not have complete information about the vendors' cost structure.

From the client firm's perspective, for the case when the open market demand distribution is Uniform and the buyer's demand is Normally distributed, we analytically derive the capacity to be procured as well as and the optimal number of vendors to be awarded the contract. Our analysis reveals that with an increase in vendor base cost heterogeneity, the optimum number of required vendors decreases. We further conclude that when the mean demand of the client firm is below a threshold value, then as the client firm's demand variability increases, the optimal number of vendors increases. Whereas, in case the client firm's mean demand is above the threshold value, then the optimal size of vendor base decreases as the client firm's demand variability increases.

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1. Introduction

In today's global services supply chain management, an increasing number of firms are adopting "multisourcing", i.e. selection and combination of business services from multiple service providers/vendors. This phenomenon has also been observed in the logistics industry, where the fleet managers of firms outsource their transportation requirements to multiple vendors (Cavalli, 2004). In the Information Technology (IT) industry, clients like the State of Georgia have also outsourced their IT infrastructure services to multiple IT service providers (Connatty & Nelson, 2015). In another example, General Motors has decided to multisource its IT operations, relying on six "tier-one" IT vendors for their service requirements (Schaffhauser, 2006; Twing, 2006).

To enhance the sourcing flexibility, firms often use a mixture of contracts, wherein, they source a portion of the demand requirement from multiple vendors through long term contracts and the balance requirement from the open marketplace (short term contract). In the logistics industry, this flexibility corresponds to deciding between term vehicles (reserved capacity) and spot vehicles (on-demand requirements) (Kocis et al., 2009). In IT outsourcing, firms also allocate their IT requirements amongst

long-term agreements with few IT vendors as well as source through short term IT outsourcing deals (Overby, 2015).

In services industry, the client firms commonly use bidding competition to select the pool of vendors for awarding the long term contracts. In practice, reverse auctions have been used to negotiate pricing for fleet management services (see Antich, 2004). General Motors also used similar bidding processes to select its "tier-one" IT vendors for its long term IT outsourcing contract (Schaffhauser, 2006). In this paper, we study bidding competition amongst multiple vendors to win the long term contract from the client firm.

Another challenge that the client firm face is the absence of complete information about the vendors' cost structure, or in other words, vendor base is likely to be heterogeneous as far as the cost structure is concerned. Chen (2003) describes the problem arising from the possession of such private information in various supply chain settings. Hence, it is interesting to understand how does the client firm determines the optimal capacity to source and the number of vendors in the context of incomplete cost information. This is one of the primary issues of interest in this paper.

Motivated from the above context, we study a scenario where the client firm (she), facing uncertain demand, wishes to reserve capacity in advance from a subset of pre-approved vendors (he) with finite capacity. We also denote this capacity reservation contract as a long-term contract in this paper. This capacity reservation is done before the client firm's demand information materializes. Furthermore, the client firm does not have complete

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information about the vendors' cost structure. The client firm has to determine the amount of capacity to book in advance and also the number of vendors to be selected. On the other hand, vendors have access to an open market where they can also sell their capacity. However, due to demand uncertainty in this market, they may not be able to sell their entire capacity. Further, the client firm can also access the open market if the reserved capacity is not sufficient to meet the demand (when the demand eventually materializes). To maintain analytical tractability, we assume that the open market demand distribution is Uniform and the buyer's demand is Normally distributed. Next, we state our main research questions along with the brief summary of our research findings related to each of the questions:

(1) *What is the impact of demand uncertainty on the optimum number of vendors to be selected for awarding the contract and the total contracted capacity?*

We find, when the mean demand of the client firm is below a certain threshold value then as demand variability increases, the optimal size of the vendor network increases. In this region (where mean demand is below the threshold value), the client firm also increases the total contracted capacity as the demand variability increases. However, in case the client firm's mean demand is above the threshold value, the optimal size of vendor base decreases as the demand variability increases. In this region (where mean demand is above the threshold value), the client firm decreases the total contracted capacity with the increase in the demand variability. Hence, in IT outsourcing practice, if the scale of business of the client firm is small (for example, startups), the sourcing manager at the client firm should increase the total capacity to be reserved through bidding competitions. Whereas if the scale of business is large, the sourcing manager should increase the "on demand" capacity requirements with an increase in the demand uncertainties.

(2) *What is the impact of the vendors' cost variation (heterogeneity) on the optimal size of the vendor base and the total contracted capacity?*

Our analysis reveals that as the vendor base cost heterogeneity increases, the optimum size of vendor network decreases. The client firm decreases her total contracted capacity as the cost variability increases until a certain threshold on cost variability. After the threshold value of cost variability, the total contracted capacity increases as the cost variability increases. In IT outsourcing business practice, if the outsourced services gets matured over time the cost heterogeneity among the vendors decreases. Now, in such a scenario, the sourcing manager at the client firm should increase the number of vendors in supply base. Later in the paper, we also link this managerial insight to examples from IT outsourcing business practice.

The rest of this paper is organized as follows. Section 2 surveys the relevant literature, while the underlying model is described in Section 3. In Section 4, we characterize the client firm's optimal sourcing strategy and discuss managerial implications of the study. This is followed by model extensions in Section 5. We finally conclude the paper in Section 6.

2. Literature review

We review three streams of literature pertinent to our research. The first set of studies pertains to the issue of cost heterogeneity in the vendor/supply base. The second stream of research essentially addresses the issue of vendor/supplier selection and the third stream pertains to the use of contracting mechanisms for better supply coordination in a setting of uncertain market demand faced by the buyer/client.

2.1. Cost heterogeneity in the vendor-base literature

A few studies in the recent past have investigated SCM problems pertaining to a cost heterogeneous supply base. Li and Debo (2009a) analyzed optimal strategies for contracting with a high cost and a low cost vendor and concluded that in periods of demand uncertainty, the high cost vendor is more favored. In another paper, they modeled a situation involving multiple vendors whose cost information is private and explored the value of commitment through long term contracts with vendors. They used a competitive bidding process to elicit vendors' cost (Li & Debo, 2009b). Bandyopadhyay, Barron, and Chaturvedi (2005) analyzed the competitive behavior of multiple sellers, who represent a cost heterogeneous supply base. The cost heterogeneity is modeled in a setting where all the individual costs of competing vendors are sampled from a common distribution. Our model also makes a similar assumption. Cachon and Zhang (2006) modeled a vendor selection scenario in which the client firm does not know the competing vendors' cost and utilizes a queuing model to minimize its procurement and operating cost. Similar to our setting in this paper, they also assumed the vendors to have identical capacities while having costs which are varying.

2.2. Sourcing in supply chain literature

Most approaches deal with the supplier selection problem using price, quality and other factors. Weber, Current, and Benton (1991) provides a review of research on supplier selection methods using these approaches. However, these approaches did not address the problems arising out of information asymmetry. Recently, Ozer and Raz (2011) have explored the impact of information asymmetry in supply chain sourcing.

Minner (2003) reviews the research contribution done in the area of multiple supply options. According to the author, one of the future research issues is the emerging significance of electronic procurement and internet technologies which reduce transaction costs. This helps to enable order placement with several suppliers and therefore makes multiple-supplier models more attractive compared to the single sourcing alternative. The scenario studied in our paper closely maps to this context. Elmaghraby (2000) reviews the trends in the sourcing literature and identifies that a central issue of multiple sourcing – the number of vendors to be selected. In a multiple–supplier, single-buyer setting, presence of multiple suppliers permits the buyer to setup a competitive mechanism, such as a bidding process for capacity allocation amongst the selected suppliers. Several studies utilized such a process as we also do in this paper.

There is a stream of paper specific to service supply-chain management, which is relevant to our research. We refer readers to Wang, Wallace, Shen, and Choi (2015) and Choi, Wallace, and Wang (2016) for a comprehensive review on service supply chain management. Gera and Xia (2011) in a service supply chain context study the customer's cloud adoption decisions from cloud vendors. Recent papers, which study sourcing issues in services industry include work by Benjaafar, Elahi, and Donohue (2007) (compares vendor capacity allocation rules), Bernstein and De Véricourt (2008) (procurement contracts with service guarantees) and Jin and Ryan (2012) (fill-rate competition among vendors). Wang and Wallace (2016) study the impact of spot markets with excess capacity on service network design problems.

According to Samantra, Datta, and Mahapatra (2014), hidden sourcing costs and unexpected outcomes can also be viewed as risks in IT outsourcing. Using fuzzy set theory, they develop a