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# Scope economies, market information, and make-or-buy decision under asymmetric information

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ABSTRACT

This paper presents a make-or-buy (M–B) model in which a firm (say Firm 1) may produce in-house, or outsource a product to the unique vendor, the monopolist in the outsourcing market. Demand for the finished product is stochastic and price-sensitive, and Firm 1's information forecast about the base market demand and corresponding precision are known when the M–B decision is faced. Firm 1 is risk-neutral and owns a constant-return-to-scale technology, while the vendor is risk-averse and enjoys the advantage of scope economies. A traditional solution is provided under perfect information.

Under asymmetric information, we demonstrate that when outsourcing is realized, both parties' expected profits increase with (Firm 1's) forecast accuracy only if the forecasted market demand is higher than the base demand (i.e., "good" news). Outsourcing strictly dominates in-house production if the yield of the vendor's production input is sufficiently low or its economies of scope are remarkably attractive. Furthermore, it is optimal for Firm 1 to hide information at first and decide whether or not to share information only after the vendor's supply price is announced. However, the vendor's profit is constrained by the trade-off between the coordination effort for impelling Firm 1 to share information and the advantages of its monopoly on outsourcing market, low production costs, as well as scope economies.



## 1. Introduction

In general, a value chain involves several segments such as research and development (R&D), manufacturing and marketing departments, each of which is in charge of specific functions. However, a firm may outsource additional segments to an external vendor. Due to operation efficiency, the virtue of cost cutting, and technological advantage, many firms have begun to outsource their in-house productions (e.g., Domberger, 1999; Shy and Stenbacka, 2003; Grossman and Helpman, 2002, 2005). As pointed out by Brown and Linden (2005), U.S. firms in the semiconductor industry have experienced a historic evolution of offshoring: first assembly (since the late 1960s), then fabrication (since mid-1980s) and finally design (started in the 1990s). Nevertheless, many sources report on firms that complain about the results of outsourcing being far below expectations. For example, Quinn and Hilmer (1994) argue that "companies end up with large numbers of subcontractors which may be more costly to manage than in-house operations that are less efficient" (p. 47). Similarly, a few Japan and western firms such as Kenwood and Dell have shifted some of their overseas productions or services to insourcing (Antelo and Bru, 2010).

Make-or-buy (M–B) decision has been investigated for decades. In particular, several recent studies discuss the outsourcing strategy under market uncertainty. This research can be mainly categorized into two streams: the impact of market uncertainty on the proportion of outsourcing (partial outsourcing) (e.g., Shy and Stenbacka, 2005; Alvarez and Stenbacka, 2007; Moon, 2010), and the impact of market uncertainty on the timing of outsourcing (e.g., Alvarez and Stenbacka, 2007; Moon, 2010; Antelo and Bru, 2010). Most recently, Xu et al. (2012) provide a real options valuation approach for in-house modular production under market uncertainty. Tjader et al. (2013) establish an integrated analytic network process (ANP) and balanced scorecard (BSC) framework for firm-level IT outsourcing decisions. Elahi (2013) considers an outsourcing problem with a single buyer and multiple suppliers and compares two competition parameters, namely, service level and inventory level.

Economies of scale and scope are known as critical incentives for outsourcing (Finlay and King, 1999; Kakabadse and Kakabadse, 2002, 2005; Ni et al., 2009). Firms outsource part of their activities to achieve cost advantages through economies of scope and scale owned by vendors (Loh and Venkatraman, 1992; Slaughter and

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Ang, 1996; Ang and Straub, 1998). Cachon and Harker (2002) suggest that economies of scale provide a strong motivation for outsourcing under price competition. Ni et al. (2009) argue that both scope economies and high in-house production cost account for multi-client outsourcing under quantity competition. While there is a considerable economics and marketing literature that identifies scope economies and develops strategies to exploit them, relatively little is known about the specific conditions under which a firm is better off with outsourcing or in-house production. In our model, we apply a simple method to analyze the effect of scope economies on a firm's M–B decision, so as to avoid analytical intractability.

Information sharing has an important influence on quantity and price competitions. Vives (1984) develops an information forecast method to study substitutable products in a competitive and uncertain environment. Thenceforward, this information forecast method has been widely used to deal with market uncertainty. Raju and Roy (2000) apply such an approach to examine the effects of information forecast and its precision on firm performance. Roy (2000) discusses the impact of market information on channel profitability under a competition context. Yue et al. (2006) and Mukhopadhyay et al. (2011) extend to address the pricing decision of complementary goods using Bertrand and Stackelberg models.

Even though market uncertainty influences a firm's outsourcing decision in practice, most research has overlooked the crucial issue that whether and how market information, such as the forecast of market uncertainty and its accuracy, would impact a firm's M–B decision. Without causing confusion, we always use “firm” to represent the company that seeks for potential outsourcing opportunities and let “vendor” be the company that provides outsourcing services. In this study, we adopt the information forecast method developed by Vives (1984) to analyze how the dynamic characteristics of market demand would affect a firm's expected profit and M–B decision.

Asymmetric information (AI) is a latent feature of outsourcing activities. Recently, a number of studies came out on asymmetric information and decision making. Corbett and de Groote (2000), Ha (2001), Gan et al. (2003), Corbett et al. (2004), and Mukhopadhyay et al. (2008) apply revelation principle (Fudenberg and Tirole, 1991) to design contract under asymmetric information. Mukhopadhyay et al. (2011) use an information forecast method developed by Vives (1984) and design an information share mechanism to address the pricing issue for complementary products under information asymmetry. In our model, the vendor abandons the virtual information reported by the firm and announces its supply price to guarantee a certain yield for itself. Due to the release of supply price, sharing information will not hurt the vendor all the time, so that the vendor's information could be perfect to the firm. Hence, AI in our model actually means whether or not the firm would report its private information truthfully.

In this paper, we consider a firm who may outsource a product to the unique vendor, the monopolist in the outsourcing market, or produce in-house. This vendor possesses the necessary technology to implement outsourced functions. Consistent with most research on outsourcing (e.g., van Mieghem, 1999; Cachon and Harker, 2002; Ni et al., 2009), it is assumed that the vendor furnishes outsourcing services and does not sell final products to consumers directly. As a result, the firm's M–B decision depends on the expected profits in two situations, i.e., in-house production and outsourcing. We demonstrate that information nature and forecast precision would jointly affect the firm's decision making. However, quite a few literatures (Vives, 1984; Raju and Roy, 2000; Roy, 2000; Mukhopadhyay et al., 2011) claim that firm profit always increases with forecast precision, regardless of information nature. In our context, this argument holds if and only if “good” news is received. Here good (bad) news means that the forecasted market demand is higher (lower) than the mean, which is common knowledge. Put another way, more precise “bad” news will lead to lower expected profit.

Note that, this study significantly expands and extends our conference paper (Xu et al., 2011). The main differences between them are: (i) this article provides the details of introduction, literature review, model formulation and analysis, deduction, proof, appendices, discussion and managerial implication; and (2) this article obtains a significant number of new propositions and corollaries.

The remainder of the article is organized as follows. Section 2 presents the base model. Analytical results are provided in Section 3. Our conclusions and some key directions for further research are given in Section 4.

## 2. The model

Assume that the intrinsic marginal cost of production in a given industry is a random variable that follows a low value, $c_L$, or a high value, $c_H$, where $0<c_L<c_H$. The distribution of this cost is such that $\Pr(c_L)=\mu$ and $\Pr(c_H)=1-\mu$, with $\mu\in[0,1]$. A special firm in the industry, say Firm 1, presently has unit production cost $c_H$, either because Firm 1's current production process is inefficient compared to the intrinsically low cost of the industry, or because the cost in this industry is intrinsically high. In the model, we use a linear demand function as it is widely used in economics and marketing literature (e.g., Vives, 1984; Gal-Or, 1985; Raju and Roy, 2000; Tsay and Agrawal, 2000; Li, 2002; Ni et al., 2009; Mukhopadhyay et al., 2011).

The demand function for Firm 1 is given by

$$q_1=\alpha a-\beta p_1. \tag{1}$$

$q_1$ is the demand of product 1 provided by Firm 1, which depends on its own price $p_1$ as well as the base demand in the industry $a$. The share of this base level demand going to Firm 1 is $\alpha$. The effect of its own price on demand is moderated by the coefficient $\beta$.

We further assume that the base level of demand $a$ is a random variable, allowing us to capture demand uncertainty due to the dynamic economic and market environment. More specifically we assume that

$$a=\overline{a}+\varepsilon, \tag{2}$$

where $\overline{a}$ is the mean of market demand and $\varepsilon$ is a random shock in any time period, $\varepsilon$ is assumed to be distributed normally with mean zero and variance $D$. The normality assumption has limitations because it allows for negative values of base demand. However, it has been used extensively in the literature (e.g., Vives, 1984; Raju and Roy, 2000; Roy, 2000; Mukhopadhyay et al., 2011), because it simplifies the analysis considerably and allows for closed-form solutions (Basar and Ho, 1974; Clarke, 1983; Vives, 1984; Gal-Or, 1985). Also, we assume that $\overline{a}$ is large, relative to $D$, so that the probability of negative demand is negligible.

We allow Firm 1 to forecast about the unknown base demand using the market information-gathering techniques at its disposal. We further assume information is costless. Define $f_1$ as Firm 1's forecast. We assume that

$$f_1=a+\xi, \tag{3}$$

where $\xi$ is normally distributed, independent of the base demand $a$, with mean zero and variance $S$. A higher (lower) variance implies a less (more) precise forecast. The forecast will be more accurate, or say, the value of $S$ is smaller, if Firm 1 uses appropriate data and information forecast technologies.

We use the result from Vives (1984),[1] which show that the expected value of the base demand, given forecast $f_1$, is a convex

[1] Note that, Gal-Or (1985), Raju and Roy (2000), Roy (2000), and Mukhopadhyay et al. (2011) use the same result from Vives (1984).