



## In-house capability and supply chain decisions

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### ABSTRACT

This study considers an internal production option for a contractor and analyzes its effect on the supply chain decisions when the contractor has innovated and the subcontractor has an incentive for opportunistic behavior. In contrast to the single disclosure threshold in the benchmark scenario where the contractor lacks in-house capability, we find two thresholds in the referred scenario. When information misappropriation is possible and the contractor has in-house capability, the contractor will organize a coordinated supply chain only when innovations fall between the two thresholds. Compared to the benchmark scenario, in-house capability has a positive effect on the contractor's incentive to innovate and an ambiguous effect on the subcontractor's incentive to invest in the production process. When the contractor needs to incur an extra cost to build in-house capability, the contractor keeps the same levels of investment compared to the case of no additional in-house capability cost, whereas the subcontractor increases the levels of investment. Furthermore, we find that in the presence of potential misappropriation on the part of the subcontractor, the higher the level of in-house capability, the less likely the contractor will be to outsource innovative products that generate higher profitability. This study can explain why firms strategically outsource low-end products and produce high-end products themselves. This study provides new results on the effects of in-house capability on the strategic interactions of parties in supply chains and, hence, on supply chain efficiency.

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### 1. Introduction

Studies in the field of outsourcing have primarily focused on the decision to outsource and have examined the determinants, motivations, and benefits of the make-or-buy decision. There are increasing numbers of outsourcing firms in a supply chain adopting the make-and-buy strategy. For example, the Intel Corporation produced internally its new 855 chipset for Centrino mobile technology and asserted that no third-party chipset manufacturers would be granted the licensing agreement to manufacture compatible devices in the near future [14]. In the mobile handset industry, Apple relies on contract manufacturers for all of its high-end smart phones due to a lack of in-house manufacturing capability. Nokia and Motorola (with in-house capabilities) engage in substantial outsourcing but to different degrees [1]. In general, these firms strategically outsource low-end products and manufacture high-end products in-house.

Although many studies on supply chain management indicate the importance of coordination among supply chain partners to improve performance (e.g., [8]), few studies have adopted models using the cooperative game theory, which appears to be a natural framework for analyses of this sort [21]<sup>4</sup>. This study uses a simple, yet strategically significant, bargaining model (Nash bargaining model) to explain this commonly observed phenomenon. Specifically, this study uses an outsourcing context to explore the role of a contractor's in-house capability in directing the behavior of the contracting parties and coordinating supply chains. We also develop an empirical analysis to validate our analytical model with the goal of providing insights into the effect of in-house capability on supply chain efficiency.

To improve production efficiency and lower costs, firms have begun to look beyond their own boundaries and to consider the overall design of their supply chains [6]. Specifically, firms appear to focus on functions that are central to gaining a competitive advantage, and they outsource low-value-added activities to

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<sup>4</sup> Previous researchers, such as Li et al. [17] and Hua and Li [12], have used the Nash bargaining model to study issues concerning manufacturer–retailer supply chains. Nagarajan and Sosis [21] have surveyed some studies of applying cooperative game theory (e.g., Nash bargaining model) to supply chain management.

members in their supply chains [23]. However, some surveys report that most firms have brought previously outsourced activities back in-house (see [25]). Hughes and Weiss [13] note that failed relationships in a supply chain may result from a lack of trust between contracting parties. Although researchers (e.g., [27,15,18,9]) have explored alternative outsourcing contexts, relatively few studies have examined how subcontractor opportunism affects make-or-buy decisions of the contractor, and even fewer have explored how this in-house capability affects supply chain decisions.

The objective of this study is to explore how contractors' in-house capabilities interact with subcontractors' potential misappropriation and affect the contractors' make-or-buy decisions. Specifically, this study considers an internal production option for the contractor and analyzes its effects on supply chain decisions when the contractor has innovations that could serve as incentive for opportunistic behavior on the part of the subcontractor. Two scenarios are used to facilitate the analysis. The *benchmark scenario* (hereafter, B-scenario) represents a situation in which subcontractor misappropriation exists and the contractor lacks in-house capability. The *referred scenario* (hereafter, R-scenario) denotes a situation in which the contractor has the ability to produce in-house and subcontractor misappropriation exists. From the model analysis, we obtain the following results. In contrast to the single threshold obtained in the B-scenario, the contractor encounters two thresholds in the R-scenario (even in the situation that the contractor must incur extra costs to build up in-house capability). The contractor would outsource and organize a coordinated supply chain only when innovations fall between the two thresholds. Compared to the B-scenario, in-house capability has a positive effect on the contractor's incentive to innovate and an ambiguous effect on the subcontractor's incentive to invest in the production process. Even when the contractor must incur an extra cost to build in-house capability, he maintains the same levels of investment as they are when no extra cost for in-house capability is required, whereas the subcontractor increases the levels of process-related investment. From the empirical analysis, we find if potential misappropriation on the part of a subcontractor exists, the greater the benefits that a subcontractor would realize through misappropriation, the less likely a contractor would be to outsource innovative products. In addition, the higher the level of in-house capability, the less likely the contractor is to outsource innovative products that generate higher profitability. Hence, we emphasize that in-house capability not only provides an alternative manufacturing source for a contractor but also helps to mitigate risks stemming from outsourcing activities and enhance supply chain efficiency.

Our work is related to Baiman and Rajan [4], Parmigiani [23], and Kaya [15]. Baiman and Rajan [4] disregard the contractor's in-house capability and explore which innovations the contractor will choose to establish an arm's-length relationship with the subcontractor. Our work differs from that of Baiman and Rajan [4] in that we consider the option of internal production for the contractor and explore how the in-house capabilities affect the supply chain decisions. We conduct a comparison between the B-Scenario (the contractor lacks in-house capability) and the R-scenario. Parmigiani [23] directly examines the determinants of make-or-buy decisions. Our work differs from that study in that we focus on identifying the determinants of the contractor's innovation information-sharing strategies. We examine how these determinants affect the contractor's information-sharing strategies and the make-or-buy decisions. Kaya [15] compares contracts and identifies which contracts can help coordinate the supply chain in outsourcing and in-house production models, respectively. However, our work differs from that of Kaya [15] in that we abstract away from the optimal contracting issues and place emphasis on comparing outsourcing and in-house

production scenarios. We focus on exploring the effects of in-house capabilities on supply chain efficiency.

The remainder of the study is organized as follows. Section 2 describes and formulates the analytical model. Section 3 characterizes the bargaining game. Section 4 implements an empirical analysis. Section 5 provides the conclusion and future research suggestions.

## 2. The model

The study uses an outsourcing context to study a one-period supply chain coordination game. In the supply chain, a risk-neutral contractor and a risk-neutral subcontractor collaborate by making relationship-specific investments to facilitate a new and differentiated product (hereafter, the "new" product). The subcontractor has comparative advantages in producing products. The contractor has comparative advantages in selling the "new" product. In the absence of any contractual risk, the contractor must outsource products from the subcontractor before selling those products to a consumer market. The price of the "new" product per unit at which the contractor can sell to the market depends upon the quality of the "new" product. This study assumes that the subcontractor has the capacity and the necessary incentives to fulfill the orders submitted by the contractor and that the contractor has a ready market for selling the "new" product to consumers. This model fits the commonly observed supply chain phenomenon in business.

The major benefit of such a supply chain arrangement, absence of a risk that the subcontractor will misappropriate the information of the "new" product, arises from the full sharing of proprietary information between the contracting parties.<sup>5</sup> The contractor possesses the innovation information of the "new" product, which is often proprietary and tends to be revealed to the subcontractor ahead of the design and production phases. The subcontractor, therefore, has an opportunity to misappropriate the information without joining the supply chain relationship. With full information sharing, we can reasonably assume that the total profits will increase. While misappropriation of this information can increase the net share for the subcontractor, the contractor can seek legal protection to deter the subcontractor from misappropriating this information. However, the legal process of patent protection and/or a lawsuit is long, expensive, and frequently unreliable; often the property rights over patents are difficult to identify and defend. Furthermore, perfect information sharing may not be possible and the resultant value from the collaboration may decrease. Consequently, this study assumes an imperfect legal environment, so misappropriation of innovation information is a possibility. This study also assumes that the benefits from such opportunistic behavior cannot be contracted on, which makes the game between the contractor and the subcontractor incomplete. This study is motivated to use incomplete contracting to perform the analysis.<sup>6</sup>

If the subcontractor can misappropriate only parts of the contractor's innovation information, the setting is entirely consistent with our model. Clearly, the simplest way for the contractor to control the misappropriation is to restrict the information shared with the subcontractor, that is, the

<sup>5</sup> A great deal of the supply chain researches emphasize that sharing information is a main channel for coordinating supply chains (see, for example, [7,16,11]).

<sup>6</sup> Williamson [26] indicates that writing and monitoring a complete contract would be prohibitively expensive when transactions involve a high degree of asset specificity associated with opportunism. This implies that contracting parties will sign incomplete contracts. See, for example, Hart and Moore [10], for related discussion of incomplete contracting.

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