



Single versus multiple sourcing and the evolution of bargaining positions[☆]



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ABSTRACT

The size and importance of global contract manufacturers has risen along with the volume and pervasiveness of global subcontracting activities. Many contract manufacturers now equal or even dominate their customers in size and power, ending the historical dominance of original equipment manufacturers in subcontracting relations. We study a manufacturer's (or buyer's) single-versus-multiple sourcing decision under specific consideration of the effects on the evolution of power between the buyer and its supply base. Motivated by the trend towards less hierarchical sourcing relationships, we use the generalized Nash bargaining framework to model contract negotiations. Being awarded a contract allows suppliers to progress on their learning curves, leading to lower future production costs. The buyer's primary trade-off between single and multiple sourcing then is as follows. Whereas single sourcing leads to more pronounced learning effects and thus more drastic cost reductions, it increases the active supplier's relative bargaining position, as the buyer's outside option becomes comparatively less competitive. Considering this trade-off, we find that the buyer's optimal sourcing strategy depends on both its bargaining capabilities and the rate at which learning by doing reduces production costs. A powerful buyer might indeed prefer single sourcing, but weaker buyers will generally be better off splitting their volume between different suppliers to maintain a viable alternative source. While splitting the volume maximizes a weak buying firm's profit, it always leads to inefficiencies, since the highest possible system profit would be achieved by concentrating learning effects at one supplier (single sourcing).

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1. Introduction

The importance of production outsourcing and contract manufacturing has dramatically increased over the last decades. While firms have used outsourcing to reduce costs and focus on their core competencies for quite some time, the continuing improvements in the capabilities of the global supply base has accelerated this trend. Nowadays, subcontracting or outsourcing is no longer limited to fairly simple or standardized processes, but it often includes complex tasks that are customized to very specific needs of the buyer. For example, car producers subcontract increasingly complex subsystems to their suppliers, and many original equipment manufacturers in the electronics industry (for example, Dell, Apple, Hewlett-Packard, Microsoft) subcontract large parts of the production of their products to firms like Hon Hai Precision Industries (Foxconn) or Flextronics, which have grown dramatically over the past years, both in size and in influence [10,19].

When outsourcing parts of its production processes, a firm can decide to work with just one supplier (single sourcing), or to distribute

the work between two or more suppliers (multiple sourcing). In recent years, many firms have consolidated their supply bases, often using single suppliers for a large portion of their supplies, but some firms also follow multiple-sourcing strategies; for example, Apple sources its iPhone touchscreen displays from different suppliers, presumably to maintain competition [17].

The potential benefits associated with single sourcing include production cost reductions due to scale economies and learning effects, lower inventories and better quality due to just-in-time and continuous improvement initiatives, stronger relationships and reduced administrative costs. On the other hand, dual (or multiple) sourcing might help reduce a firm's exposure to various types of risk, offering protection, for example, in the event of shortages, strikes, natural disasters, or in the presence of technological uncertainty (see, for example, [32,7]).

The diversification benefit of a second source in the presence of uncertainty has been well-established (for example, see [31,30,54,38,33,36,35,12,41]). In this paper, we eliminate all risk-pooling-based drivers for multiple-sourcing; all current and future developments are common knowledge and deterministic. There is also a wide stream of research that has studied supplier selection decisions when suppliers differ in terms of cost, quality, or reliability, or when sourcing decisions are affected by scale economies, quantity discounts, or correlated risks (for example, see [26,13,39,27,20,28]). While most of the

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literature (and all of the above-mentioned papers) consider optimal supply chain design decisions in single-period models, we examine a buyer's strategic decision between single and multiple sourcing focusing on the evolution of power between the buyer and its supply base. The source of this power shift over time stems from the cost improvements that suppliers experience as they progress on their learning curves.

Dual sourcing might also avoid dependency from a potentially complacent supplier, and it introduces supplier competition that might lead to improved performance and better contract terms. There is an extensive body of research on a firm's optimal sourcing strategies, including a large substream that examines the pros and cons of sourcing from a single supplier versus sourcing from two or multiple suppliers. Li and Debo [17,18] study the trade-offs between commitment to a single supplier, which leads to higher profitability at the outset, and the value of keeping an option to access a second supplier in future periods; such an option can be beneficial as it maintains a certain level of competitive pressure on the supplier; Li [16] investigates the interactions between a firm's sourcing strategy (single or dual sourcing) and the format of contractual agreements. However, neither of these articles focuses on the strategic interactions induced as sourcing decisions in one period affect supplier costs and bargaining positions through learning effects.

Much of the extant literature analyzes the decision between single and multiple sourcing under the assumption that the buyer has sufficient power to determine the conditions of the sourcing relationship. For example, the buyer might be able to conduct and design auctions or make take-it-or-leave-it offers to its suppliers. While some buyers do indeed possess such power, many modern sourcing relationships are much less hierarchical. Indeed, contract manufacturers in many industries are continuously gaining in size and influence, leading them to demand some concessions when negotiating the details of the sourcing relationship. This trend is especially prevalent for production needs that are customized and specific to the often complex needs of a certain buyer. Unlike the outsourcing or subcontracting of simple processes, the sourcing relations for such complex products (or subsequent generations of the same product) become increasingly involved and can be long-lived. Rather than opening contract continuation to a wide set of new suppliers or prescribing contract terms over time, in such relationships a buyer's decision to engage with certain suppliers leads to at least some dependence from these suppliers in future periods, as switching to a new set of suppliers is associated with potentially substantial costs (negotiations, specification and control of processes, lost experience and thus higher costs, etc.)

There is wide empirical support for the notion that experience makes people and organizations better at doing something, that is, they are learning by doing. This observation has often been formalized through *learning curves*, which, in their original form, relate unit costs to production volume: as cumulative production volume increases, unit costs decrease, though at a diminishing rate [34]. The phenomenon of such learning has been observed at many different levels (individual, group, factories, firm, industry), for different performance measures (for example, cost, total productivity, quality, profitability, firm survival), and across many types of industries (for example, see [37,6,21,2]).

In the presence of such learning effects, single sourcing enhances the learning experienced by the active supplier and thus reduces its costs, but this strategy also increases the buyer's dependence on this supplier, as alternative supply sources become comparatively less and less competitive. As a consequence, the buyer's outside options might be limited and the buyer might not be able to extract much of the benefits derived from the supplier's cost reductions. In order to analyze the consequences of such a power evolution, we assume that the buyer engages in bilateral negotiations with the different suppliers, where each bilateral negotiation is modeled

using the generalized Nash bargaining solution (henceforth GNBS, cf. [23,24]). The evolution of the buyer's relative negotiation position is then captured by assuming that, in the negotiation with any given supplier, the buyer can use alternative supply sources as threat points. (We discuss our mathematical framework in more detail in Section 2.)

Specifically, this research addresses the question if and how a buyer's optimal sourcing strategy changes if the distribution of profits between the buyer and its suppliers is determined through repeated bilateral negotiations rather than dominated by a buyer who can determine the format of an auction or make take-it-or-leave-it offers to the suppliers. We examine when it is better to use single sourcing to maximize the cost savings experienced by the active supplier, and when multiple sourcing is preferable, as it decreases the buyer's dependence on any single supplier in its supply base.

Focusing on such learning curve and supply competition effects (and controlling for other factors that affect the single versus multiple sourcing decision), we show that single sourcing is a dominant strategy for a powerful buyer who can more or less dictate the terms of trade (subject to individual rationality constraints). Single sourcing also maximizes system profitability, that is, the aggregate surplus of all parties. However, when a buyer is less dominant and when the terms of the relationship are set in negotiations with the suppliers, we find that it primarily depends on two factors which sourcing strategy is optimal, namely the rate at which production costs decline as production volume increases, and the buyer's relative negotiation power, that is, how much can the buyer can extract from the surplus under negotiation.

There are some papers that have considered similar trade-offs in procurement auction frameworks; again, we refer the interested reader to Elmaghraby [7] for an extensive review of this and related literature. Among these papers, Klotz and Chatterjee [15] and Inderst [14] seem especially related to our work. Klotz and Chatterjee [15] consider the implications of dual sourcing in repeated procurement auctions in the presence of production learning and entry costs. As in our model, single sourcing in the first period maximizes learning effects, but also reduces the relative competitiveness of the unemployed supplier, who then might decide against costly bidding in future periods. Employing both suppliers (dual sourcing) leads to a more level playing field and increased future supplier competition, as both suppliers experience some production learning. Inderst [14] considers single versus multiple sourcing decisions in a framework with two buyers and two suppliers. He finds that with competition by a second buyer single sourcing is optimal only for a sufficiently powerful buyer, that is, a buyer that controls a sufficiently large market share. Our research theme is very similar to that of Klotz and Chatterjee [15] and Inderst [14], and some of our insights on the implications of a buyer's single versus multiple sourcing decision on supplier competition are based on a similar intuition. However, rather than through auctions, in our model the buyer and the suppliers determine the terms of their sourcing relationship through bargaining, which might be a more appropriate representation of settings where firms (repeatedly) negotiate over sourcing costs.

Our modeling approach is very similar to that taken by Adin and Heese [3], who consider the bargaining between a retailer and the manufacturers of the products that are candidates for the retailer's assortment. Feng and Lu [8] also investigate the impact of sourcing decisions in a framework with negotiations that are modeled via the GNBS. Feng and Lu [8] study a setting with two suppliers and two buyers, who can outsource their production activities either to exclusive suppliers or to a common supplier. In their bilateral supplier-buyer negotiations, the buyers' disagreement options correspond to their profits under in-house production, while, in the common supplier scenario, the supplier can threaten with selling to the other buyer. (For the exclusive supplier scenario, the suppliers' disagreement payoffs are zero.) As a

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