Production, Manufacturing and Logistics

Dual sourcing in the age of near-shoring: Trading off stochastic capacity limitations and long lead times

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1. Introduction

With the rise of reshoring options and growth of B2B supply platforms, the complexity of sourcing management in the supply chain is increasing. Recent studies by BCG (2014b) and others suggest that the cost of sourcing in the U.S.A. may be approaching the cost of producing in China due to matters such as the rising wages in coastal China, the increase in transportation costs from more remote regions in China, the exchange rate developments of the RMB vs. the USD, and the growth in productivity in the U.S.A. due to extensive automation. The realization that the economics of manufacturing are swinging in favor of the U.S.A. has seen companies becoming interested in shifting manufacturing back to the U.S.A., for both goods to be sold at home and those intended for major export markets. The BCG’s survey found that the number of respondents saying that their companies are already bringing production back from China to the United States had risen by 20%, from roughly 13 to 16% in the past year (BCG, 2014a). Similar developments are taking place in Europe.

Although the comparative attractiveness of the U.S.A. and other developed economies has increased, the current nearsourcing trend is facing several challenges. The traditionally presumed unlimited capacity availability of nearshore manufacturing options may be decreasing due to the fact that so much capacity has been taken out of the system over the past two decades and that widespread automation is reducing the ability to respond to short-term changes in demand. Companies would have to rebuild their supply chains and identify people with the right skills to handle the increasingly sophisticated automated operations. In an executive survey by Alix Partners (2014), the respondents mention that the challenges center on the availability and capability of the local workforce, and the capability and flexibility of suppliers. In addition, with one-third of U.S. 3PLs reporting increased volumes and revenues as a result of nearshoring, their CEOs are also reporting capacity shortages across transport modes, including truckload, LTL, intermodal and rail, with the outcome that “The capacity crunch has led to higher rates and longer transit times with 3PLs struggling to meet on-time service goals and cost targets” (Penske Logistics, 2014).

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https://doi.org/10.1016/j.ejor.2017.11.030
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The fact that manufacturing jobs are coming back to developed economies due to reshoring, does not mean that they are not continuing to develop in Asia and other developing countries. In fact, the number of global sourcing options is still growing, with the global supply chains effectively pooling the global manufacturing capacities and making them available to companies worldwide. For instance, the rise of B2B platforms such as Alibaba, enables suppliers from further away to flexibly respond to market needs, albeit with longer (transportation) lead times.

As a consequence, the trade-offs in dual sourcing are changing. Most research in dual sourcing studies the trade-offs between a nearshoring option that is more expensive and faster against an offshore option that is cheaper but requires a longer lead time. Yet the developments described above suggest that at least for part of the product portfolio the trade-off may be less about product cost, and nearby suppliers may be faster but not necessarily more flexible. They may suffer from limited capacity availability.

In this paper, we focus on such a newly developing trade-off. We study the problem of a manufacturer procuring a component for the production of a finished product, where two sourcing options are considered: a faster, yet partially available source, and a slower, yet fully available source. Both sources supply at the same landed cost. In this case, it is unlikely that the faster source is always favorable. In any case, supplying from the faster nearshore source will involve uncertainties related to the current capacity availability, which could result in uncertain replenishment to the manufacturer. This uncertainty would need to be hedged using the slower, presumably uncapacitated, offshore source. When a manufacturer experiences or anticipates a supply shortage of the nearshore source, a decision has to be made concerning the extent to which the slower offshore source should also be utilized. Due to the sourcing lead time, the ordering decisions are made before demand for the finished product is realized. Thus, the decision maker is facing both, the uncertain replenishment from the fast supply source, and the uncertainty of demand for the finished product, and needs to allocate the replenishment between the two supply sources.

To study this, we model a zero-lead-time supply source that is stochastic capacitated, where the supply capacity is exogenous to the manufacturer and the actual capacity realization is only revealed upon replenishment. The reliable positive lead time supply source is modeled as uncapacitated with a fixed one-period lead time. Both the supply capacity of the nearshore source and the demand are assumed to be stochastic and non-stationary with known distributions in each time period. Unmet demand is backordered. In each period the manufacturer places the order with the fast source, the slow source, or with both sources. Our goal is to find an optimal policy that minimizes the inventory holding costs and backorder costs over a finite planning horizon. See Fig. 1 for a sketch of the supply chain under study.

1.1. Related literature

We proceed with a review of the relevant literature on supply uncertainty models in a single-stage setting, where our interest lies in two research tracks: single sourcing inventory models with random capacity and dual-sourcing models with suppliers that differ in their delivery times and/or supply capacity availability. The way we model the supply capacity of the faster supply source is in line with the work of Ciarallo, Akella, and Morton (1994), Iida (2002), Jakšić, Fransoo, Tan, de Kok, and Rusjan (2011), Khang and Fujiwara (2000) and Jakšić and Fransoo (2015), where the random supply/production capacity determines a random upper bound on the supply availability in each period. For a finite horizon stationary inventory model they show that the optimal policy is a base-stock policy (or a modified base-stock policy if capacity is known prior to placing an order), where the optimal base-stock level is increased to account for possible, albeit uncertain, capacity shortfalls in future periods. An important observation for our work is the insight provided by Ciarallo et al. (1994) in their analysis of a single-period problem, where they show that stochastic capacity does not affect the order policy. The myopic policy of the newsvendor type is optimal to cover the demand uncertainty, meaning that the decision maker is not better off by asking for a quantity higher than that of an uncapacitated case.

For a general review of multiple supplier inventory models we refer the interested reader to Minner (2003). The review is based on the important criteria for the supplier choice, mainly the price and the supplier’s service. A more focused review of multiple sourcing inventory models when supply components are uncertain by Tajalkhsh, Zolfaghari, and Lee (2007) reveals that most of these models consider uncertainty either in supply lead time, supply yield, or supplier availability. More specifically, the review of dual-sourcing literature shows that a series of papers shares some basic modeling assumptions with our model: dual-sourcing periodic review with deterministic lead times that are different for the two supply sources. These papers can be divided into two streams depending on the assumptions on supply capacity availability, where for the first stream the assumption of unconstrained suppliers holds, while for the second some sort of capacity constraint is introduced at the faster supplier or both suppliers. Most of these papers rely on the price difference between the two suppliers that stimulates the manufacturer to partially source from the cheaper, slower supplier. However, we argue that in the case where the supply capacity availability at the faster supply source is limited, variable, and potentially stochastic, the above-mentioned price incentive is not needed. Thus, in our case the incentive to find the optimal dual-sourcing strategy lies in finding the right balance between the responsiveness of the faster supply source and the reliability of the slower supply source.

In the first of the two above-mentioned streams that assumes unconstrained suppliers, the search for the best dual-sourcing...
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