

# Portfolio Procurement in Supply Chain Management

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## INTRODUCTION

In the literature of supply chain management (SCM), the traditional approach to balance supply and demand is to design bilateral supply contracts in order to provide mutual benefits to both sellers and buyers. The commonly used contract parameters include decision rights, pricing, minimum purchase commitments, quantity flexibility, buy-back or returns policies, allocation rules, lead time, and quality (Tsay et al., 1999; Cachon, 2003). In business reality, however, a procurement manager may have more flexibility to receive necessary products from additional supply sources, such as spot market and option contracts.

As effective complements to the bilateral supply contracts, the spot market and the option contracts are closely related to each other. This chapter is particularly interested in optimal portfolio procurement policy under different market conditions, in which the procurement manager needs to determine the optimal quantity of physical products and option contracts to purchase.

## BACKGROUND

In past decades, the advances of IT technology and systems engineering in logistic, transportation, and SCM have induced the establishments of many business-to-business (B2B) spot markets in various industries, such as chemicals, electric power, metals, natural gas, plastics, and semiconductors (Cohen et al., 2003). In the spot markets, prod-

ucts are traded for cash and delivered in a timely manner, giving procurement managers much flexibility to meet customer demand. Comparing to the bilateral supply contracts, however, the spot price fluctuates more dramatically depending on the instantaneous balance of supply and demand. As a result, the procurement manager can use the spot market as an essential complement to the bilateral supply contracts. In order to develop optimal procurement policies, the procurement manager need to understand how to allocate their resources on both the supply contracts and the spot markets.

Another alternative approach to improve supply chain efficiency is option contracts, which can either be purchased from financial markets or signed by the supplier and the buyer for special clauses. An option contract usually involves a two-part fee structure. The buyer agrees to pay an upfront cost to reserve certain amount of supply in the future at a fixed price, but he can decide whether to exercise the option contract after more demand information is observed. If he decides to exercise the option contract, then he needs to pay the unit product cost according to the option contract, no matter what the current price in the spot market. At the same time, the supplier has to ensure the availability of all reserved amount at the designated day. The option contracts not only can effectively hedge against price and supply risks, but also can reduce the coordination cost between the suppliers and buyers (Wu & Kleindorfer, 2005).

Therefore, the basic question of interest to the procurement manager is how to use portfolio

procurement policy (the combination of bilateral supply contract, spot market, and option contracts) to optimize supply chain performance.

## **MAIN FOCUS**

Wu et al. (2002) is arguably the earliest research on the integration of supply contract and spot market. They consider a setting with one seller and one or more buyers in a capital-intensive industry. In addition to the long-term bilateral contract between the seller and the buyers, both of them are allowed to sell excess capacity or purchase necessary outputs from the spot market to satisfy the demand. In their model, the option-type contract has two-part fee structure, the unit reservation cost and the unit execution cost if the capacity is called. Optimal solutions are derived in a von Stackelberg game, in which the seller's optimal bidding strategy and the buyers' optimal contracting strategy are both determined. Based on transaction cost economics (TCE), Kleindorfer and Wu (2003) provide a general analytic framework and survey the research and practice on the use of options in the B2B markets. Since then, many studies have been done to investigate the effect of portfolio procurement on supply chain performance. Together, they strive to address the following questions.

## **Functions of Spot Market**

Several studies have explored the functions of the spot market. For example, why should the spot market be used together with the long-term supply contracts? What kind of benefits the spot market can bring to a supply chain? Seifert et al. (2004) examine the effects of spot markets on the optimal procurement strategies by incorporating spot price dynamics and risk aversion. They derive closed-form results on the optimal ordering quantities from both forward contracts and spot markets under different restrictive assumptions

of spot procurement. By comparing to the results of pure contract sourcing, they demonstrate that companies who use the dual-sourcing approach would benefit in the improvements in expected profit and service level, but might experience higher profit volatility. Similarly, Mendelson and Tunca (2007) find that supply chain participants are able to improve efficiencies by achieving best balance between long-term supply contracts and short-term spot market operations. However, the liquidity of the spot market plays a key role to determine the effectiveness of the portfolio approach. Guo et al. (2011) show the improvement in expected discounted profit over the period by actively managing inventory via spot markets. Comparing to the simple "buy-and-wait" policy, the benefits are especially significant when the volatility of commodity price increases. Shi et al. (2011) propose a portfolio-based approach that synergizes multiple procurement means, such as long-term contracts, supply contracts with options, and spot procurement, to maximize the expected profits while hedging against the procurement risks measured as conditional value-at-risk (VAR). Multi-stage stochastic programming model is employed to evaluate optimal replenishment quantity by simultaneously considering the stochastic demand and volatile price in the spot market. They find that the portfolio procurement approach consistently outperforms other single or paired source models on expected profits and procurement risk exposures.

From a different perspective, Dong and Liu (2007) justify the existence of bilateral supply contracts in the presence of a liquid spot market. By examining the supply contracts of non-storable commodities from a risk-hedging perspective, they derive the equilibrium forward contract in a closed expression for a Nash-style game and demonstrate the risk-hedging effects of bilateral supply contracts. They argue that the fundamental value of the bilateral supply contract lies in risk reduction and that market power plays an important role in the equilibrium supply contract.

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