European Journal of Operational Research 239 (2014) 699–710

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Production, Manufacturing and Logistics

More than a second channel? Supply chain strategies in B2B spot markets

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ARTICLE INFO

Article history:
Received 3 December 2012
Accepted 19 June 2014
Available online 9 July 2014

Keywords:
Supply chain management
Pricing
Risk management
Spot market
Channel strategy

ABSTRACT

The emergence of B2B spot markets has greatly facilitated spot trading and impacted supply chain structures as well as the way commercial transactions take place between firms in many industries. While providing new opportunities, the B2B spot market also exposes participants to a price risk. This new business landscape raises some important questions on how the supplier and manufacturer should change their sales channel and procurement strategies and tailor their decisions to this changing environment. In this paper, we study the channel-choice, pricing and ordering/production decisions of the risk-averse supplier and manufacturer in a two-tier supply chain with a B2B spot market. Our analysis shows that, to benefit from the B2B spot market and control the risk exposure, the upstream supplier should develop an integrated channel-choice and pricing strategy. When the supplier adopts a dual-channel strategy, the equilibrium contract price decreases in the supplier's risk attitude, but increases in the demand uncertainty. However, it first decreases and then increases in the manufacturer's risk attitude and spot price volatility. We conclude that rather than simply being a second channel, the B2B spot market provides a strategic tool to supply chain members to achieve an advantageous position in their contract trading.
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1. Introduction

The B2B spot market has been one of the most powerful business innovations in the past decade. With growing liquidities, trading in spot markets is increasingly important to supply chain management. Commodities and service, such as chemical products, semiconductors, logistics service, plastics, electric power, metals, and agricultural products, are now widely traded in spot markets (Turban, Lee, King, Liang, & Turban, 2009). At the same time, the relationship-based long-term contract still has merits and is widely used (Kleindorfer, 2009). Kleindorfer and Wu (2003) note that firms in capital-intensive industries need to sell most of their output or capacity via contract in advance, while using the spot market to better fine tune the demand and supply. In the DRAM memory industry for example, 75–80% of DRAM is sold in advance via fixed-price contracts to computer or smartphone makers, and the remainder is sold in spot markets (Mendelson & Tunca, 2007).

Another example is the U.S. beef industry where spot trading accounts for about 60% of total fed cattle while long-term contracts between packers and larger feedlots take care of the rest. The spot market is mainly driven by a large number of small producers of cattle, and packers can also resell contract-procured fed cattle in the spot market if they are not needed for the beef production (Boyabath, Kleindorfer, & Koontz, 2011). Other examples on practices of applying the mixture of long-term contract and spot market can be found in Kleindorfer (2009) and Inderfurth, Kelle, and Kleber (2013).

Spot markets serve as a platform for the upstream firms to offload capacity or output and for the downstream firms to address shortage and excess inventory. This flexibility can help firms better match demands and supplies. However, spot market transactions also expose participants to price volatility, and supply chain members' profits (costs) cannot be fixed in advance (Grey, Olavson, & Shi, 2005). While long-term contracts can effectively hedge against commodity price risk, the lack of flexibility often comes with a quantity risk, i.e., either over stock or shortage (Dong & Liu, 2007 & Grey et al., 2005). Given the advantages and shortcomings of the spot trading and contract transaction, upstream firms may choose to sell through contract only, spot market only, or the

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http://dx.doi.org/10.1016/j.ejor.2014.06.029
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combination of them. What are then the main tradeoffs that affect upstream firms' channel choice?

Another critical issue is how supply chain members' pricing and ordering/capacity decisions are affected by the presence of a spot market. In a traditional supply chain, the upstream firm has to determine her contract sale prices and production (capacity) plans, while the downstream firm has to decide his selling price of his final product and contract order quantity. A spot market helps the upstream firm effectively sells her output/capacity due to its continuous availability. Similarly, the downstream firm can readjust his inventory in the spot market according to the updated demand information. Obviously, supply chain managers need to tailor their pricing and quantities decisions to align with this new business environment. Furthermore, the B2B spot market is likely to expose participants to a new price risk; and hence, the notion of risk management should be incorporated when studying supply chain issues involving spot trading to gain insights into how risk factors affect the strategies of the participants.

Motivated by the questions elaborated above, we consider a two-tier supply chain in the presence of a liquid spot market. The upstream firm, referred to as the supplier, produces a commodity-like product, and sells it through the long-term contract as well as in the spot market. She decides her planned output quantity (capacity) available to the manufacturer for a targeted period, and announces the contract price. In response to the supplier's offer, the manufacturer decides his contract order quantity and the selling price of his final product. Aware of the price risk in the spot market and the demand uncertainty in the final product market, both of them may be risk-averse and intend to maximize their respective mean–variance utilities. We formulate a Stackelberg game model to analyze the decisions and the performance of the two parties. This model setting matches the real operation in many supplier–manufacturer supply chains in which the downstream firm uses a perishable commodity or material with a higher storable cost to produce a final product in the presence of a liquid spot market. It can also be applied in service industries. In the sea-cargo industry, for example, carriers sells most of their capacities to forwarders in advance to reduce the demand uncertainty. The remaining spaces are sold in the spot market. Forwarders offer the value-added services to downstream shippers, they can also trade in the spot market (Xu, Kannan, Yang, Li, & Zhao, 2013).

We derive the unique equilibrium for the Stackelberg game in closed form. Our analysis shows that, to benefit from the B2B spot market and control the risk exposure, the upstream supplier should develop an integrated channel-choice and pricing strategy. When the manufacturer is more risk-averse, the supplier has three different combinations of the pricing and channel strategies at her disposal. If the expected spot price is sufficiently high, the supplier can follow a dual-channel and low-price strategy. The high expected spot price enables the supplier to produce more. To control her risk exposure, the supplier sets a lower contract price to entice the manufacturer to order more via contract. When the expected spot price is moderate, the dual-channel and high-price strategy can be followed to obtain a high profit margin from contract and clear surplus in the spot market. If the expected spot price is sufficiently low, the supplier follows the contract-only and high-price strategy. In this case, only enough will be produced to satisfy contract sales. When the manufacturer is less risk-averse, the supplier may follow a dual-channel and low-price strategy if the expected spot price is relatively high. If the expected spot price is sufficiently low, the supplier and manufacturer may not be able to reach an agreement on the contract, and the supplier sells only in the spot market. Furthermore, when the supplier adopts a dual-channel strategy, the contract price decreases in the supplier's own risk attitude and increases in the demand uncertainty; and it first decreases and then increases in the manufacturer's risk attitude as well as the spot price volatility. We can thus conclude that rather than simply being a second channel, the B2B spot market can provide a strategic tool to supply chain members to achieve an advantageous position in their contract trading.

We contribute to the literature by investigating how supply chain members can use channel and pricing strategies to gain benefits from spot trading. We also provide managerial insights, by positioning the spot market as a strategic tool, on how supply chain members use it to achieve advantageous position in their contract trading. More importantly, the integration of joint pricing and inventory/production, spot price and demand uncertainty, and supply chain members' different risk attitudes into a single framework can help managers be better equipped for more complicated decision-making settings, which are becoming more common with the development of B2B online spot markets.

The remainder of this paper is organized as follows. We review the literature in Section 2 and describe the decision models for a supplier and a manufacturer in Section 3. In Section 4, we present the Stackelberg equilibrium of the supply chain. In Section 5, we show that the supplier's channel choice and pricing strategies are governed, respectively, by a switching curve-type policy. In Section 6, we examine the effects of the risk factors on the participants' strategies, and provide a comparison with a benchmark without the spot market. We summarize our findings and present some future research opportunities in Section 7.

2. Literature review

Our work generalizes two streams of research in the literature. The first stream is on dual sourcing with a spot market. Kleindorfer and Wu (2003) and Haksöz and Seshadri (2007) provide comprehensive surveys of this literature. Lee and Whang (2002) and Dong and Durbin (2005) consider a situation in which the multiple downstream firms have the opportunity to readjust (buy and sell) through a secondary market their inventory positions built from earlier contract procurements. Peleg, Lee, and Hausman (2002) compare three procurement strategies of using the long-term contract only, the short-term spot market only, the combination of both. They find that the optimal strategy depends on the market characteristics. Milner and Kouvelis (2007) study the periodic ordering policy of a buyer when the spot price is determined through a pricing mechanism in a multiple-firm model. Boyabath et al. (2011) examine a beef supply chain in the United States where a meat packer can source inputs through long-term based window contracts and a spot market to produce two beef products. In a multi-period setting, Inderfurth et al. (2013) study the procurement problem and develop a heuristic to determine the policy parameters. Mendelson and Tunca (2007) focus on the behaviors of one supplier and multiple buyers in a supply chain in the presence of a spot market. In their model, the supplier can receive private information about her costs, and buyers can update their beliefs on the consumer demand. Gümüs, Ray, and Gurnani (2012) model a supply chain consisting of one buyer, one reliable supplier, and one unreliable supplier. They examine the underlying motivation for the unreliable supplier to offer a price and quantity guarantee contract. Wu, Kleindorfer, and Zhang (2002), Spinler, Huchzermeier, and Kleindorfer (2003), Golovachkina (2003), Wu and Kleindorfer (2005), Fu, Lee, and Teo (2010), Pei, Simchi-Levi, and Tunca (2011), among others, study the option contacts procurement in the presence of a spot market. Their focus is on option contract design.

Some papers study dual sourcing problem from a risk management perspective. Seifert, Thonemann, and Hausman (2004) show that a risk-averse firm who uses spot markets can offer a higher expected service level, but might experience a higher variability

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