



Production, Manufacturing and Logistics

## Demand information and spot price information: Supply chains trading in spot markets

Xuan Zhao<sup>a</sup>, Wei Xing<sup>b,\*</sup>, Liming Liu<sup>c,d</sup>, Shouyang Wang<sup>e</sup><sup>a</sup> School of Business and Economics, Wilfrid Laurier University, Waterloo, Ontario N2L 3C5, Canada<sup>b</sup> School of Management, Qufu Normal University, Rizhao 276826, Shandong, China<sup>c</sup> Faculty of Business, Lingnan University, Hong Kong, China<sup>d</sup> School of Management Science and Engineering, Qingdao University, Qingdao, China<sup>e</sup> Academy of Mathematics and Systems Science, Chinese Academy of Science, Beijing 100080, China

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### ABSTRACT

This paper investigates the effect of information updating on the members of a two-stage supply chain in the presence of spot market. The supplier decides the contract price. New information becomes available as time progresses. The manufacturer updates his belief on demand and/or spot price and subsequently decides the contract quantity. The demand and spot price are correlated. Thus, the new demand information also updates the belief on the spot price, and vice versa. We model the problem with an information updating Stackelberg game and derive unique equilibrium strategies. Previous studies have considered only the demand information and concluded that improved demand information always benefits the supplier. By contrast, we demonstrate that improved demand information benefits both the supplier and manufacturer if the correlation coefficient between the two uncertainties has a small positive value and benefits the manufacturer but hurts the supplier otherwise. Moreover, superior spot price information benefits only the manufacturer and always hurts the supplier. Surprisingly, superior information fails to improve the performance of the supply chain and only changes the allocation of the profits between the supplier and manufacturer. Our findings likewise provide insights into when the supplier intends to use the contract channel and which type of information updating facility or expertise to invest in if a choice must be made.

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## 1. Introduction

Information updating facilitates decision making. Accurate demand information can improve pricing strategy and inventory management. The popularity of spot markets has prompted firms to focus both on the end customer demand uncertainty and the spot price volatility of intermediate goods (e.g., raw material). Accurate information on the spot price is important for firms to manage their procurement costs. Firms collect data not only to forecast demand but also commodity price, and various methods have been explored (Anderson, Kellogg, Sallee, & Curtin, 2011; Chen, Rogoff, & Rossi, 2010). The accuracy of the information on the spot price and/or end customer demand also affects the strategies and profitability of the upstream supplier, as well as the entire supply chain.

We investigate an information updating Stackelberg game that involves both demand and spot price information. Specifically, we

consider a supply chain that consists of a risk-neutral supplier and a risk-averse manufacturer, which is a simplified situation but reasonably approximates several commodity industries. For instance, the degree of market concentration in the Asian monoethylene glycol (MEG) industry is relatively high due to significant investment and strict environment requests. The suppliers, such as MEGlobal, SINOPEC, and Shell, are large companies that are often publicly listed and can smooth out their profit variabilities. These companies can be considered risk neutral in this supplier–manufacturer game. As raw material suppliers, the companies usually provide forward contracts for their products monthly or quarterly, and the single-price (wholesale) contract is popularly used. The downstream markets are less concentrative than upstream ones and have many medium-sized manufacturers who use MEG to produce different types of products such as polyester fibers, polyethylene terephthalate resins, antifreeze formulations and other fine chemical products. Compared with their suppliers, these manufacturers are private and have relatively weaker capability to deal with risk uncertainties, and are thus considered as risk averse (Chod & Lyandres, 2011). The supplier usually decides on her contract prices several weeks before the targeted sales season,

\* Corresponding author. Tel.: +86 633 3980571.

E-mail address: [xingweimail@gmail.com](mailto:xingweimail@gmail.com) (W. Xing).

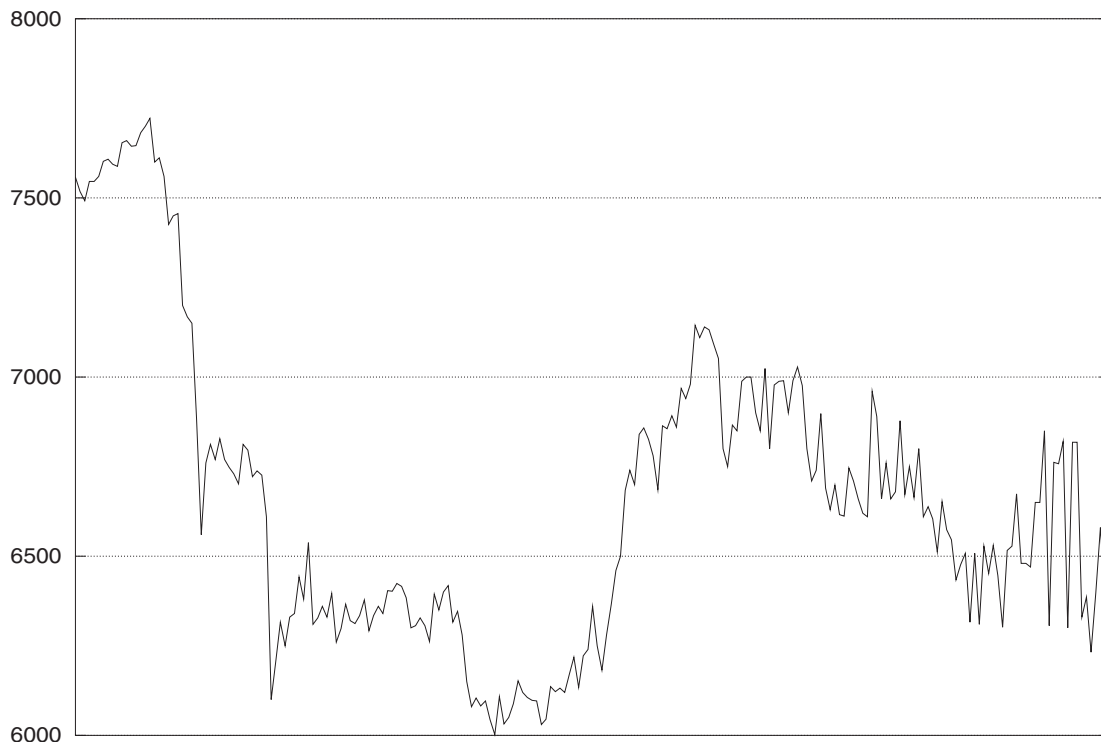


Fig. 1. Spot price of MEG in BOCE (RMB per metric ton) in 2013.

**Table 1**  
Asian contract price in 2013, MEGlobal

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.
Price	1240	1310	1310	1210	1190	1200
Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Price	1100	1140	1210	1220	1220	1200

Source: [www.315.com.cn](http://www.315.com.cn), US\$ per metric ton.

and the downstream manufacturers are required to submit the order (contract) quantity before the targeted sales season. For instance, MEGlobal usually adjusts its Asian contract price (ACP) monthly, and announces the ACP for the targeted month two or three weeks earlier.<sup>1</sup> To illustrate, Table 1 provides the ACP of MEGlobal in 2013. As the Stackelberg follower, the manufacturer typically processes more updated information when making his decision than the supplier who determines the pricing strategy earlier than the manufacturer. Moreover, the downstream firm is risk averse and has an incentive to acquire both demand and price information to control risk exposure. We use “information updating” or “forecasting” in this paper to describe information acquisition. We note that new information can be obtained as time passes even without sophisticated forecasting systems.

In addition to contract transactions, the online spot market likewise plays an important role in the Asian MEG industry. The spot market has accounted for 30 percent of the total MEG transactions in Asia, and this proportion continues to increase as the popularity of online trading grows. For instance, BOCE ([www.boce.cn](http://www.boce.cn)) is a leading online spot market in China for trading MEG. As transactions are completed online, the overhead expenses are reduced dramatically, and BOCE has attracted more than 10,000 regular market participants by 2013. Fig. 1 plots the spot price of MEG in BOCE in 2013.

Based on the preceding observations, this paper aims to understand the following important questions: (1) How does the accuracy of the demand or spot price information of a manufacturer affect the channel choice between the forward contract and spot market; for instance, does more accurate information induce a tendency of forward contract or spot sale? (2) How does the information-updating accuracy of a manufacturer affect the performances of the supplier, manufacturer, and the entire supply chain? Is a better demand/spot price information always preferred? (3) Which type of information updating is preferred by the manufacturer and supplier, information on demand or spot price? Will an agreement be achieved between the manufacturer and the supplier?

We provide the analysis with a general model framework in which the manufacturer conducts both demand and price information updating (BF). To separate the effects of these two types of information updating, we consider two special cases, namely, demand information updating (DF) and spot price information updating (SF). In the case of DF, the manufacturer may have the capability for obtaining better and more precise demand information. This scenario may represent a setting in which the manufacturer pays more attention to the demand side and sales, and this manufacturer is of the revenue-care type. In the case of SF, the manufacturer pays more attention to material procurement cost and can obtain better and more precise spot price information. This scenario may represent the setting in which the manufacturer is more concerned about its supply and procurement costs than demand and sales, and this manufacturer is of the cost-care type.

We use the property of bivariate normal distribution to derive the information updating from two random variables and solve the unique equilibrium strategies for the Stackelberg game. We subsequently obtain the condition under which the supplier intends to sell via forward contract. The contract price charged by the supplier always decreases with the spot price information accuracy but may either increase or decrease with the demand information accuracy. We further demonstrate that superior demand information benefits both the supplier and manufacturer if the correlation coefficient

<sup>1</sup> Detailed information can be found in [www.315.com.cn](http://www.315.com.cn) and [www.fibre2fashion.com/news/company-news/meglobal/](http://www.fibre2fashion.com/news/company-news/meglobal/).

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