European Journal of Operational Research 216 (2012) 356–366

Contents lists available at SciVerse ScienceDirect

European Journal of Operational Research

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

Production, Manufacturing and Logistics

The implications of postponement on contract design and channel performance

Li Jiang

Department of Logistics and Maritime Studies, Faculty of Business, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR, China

ARTICLE INFO

Article history:
Received 8 August 2009
Accepted 29 July 2011
Available online 5 August 2011

Keywords:
Supply chain management
Consignment
Revenue sharing
Postponement

ABSTRACT

We analyze a supply chain consisting of one manufacturer and one retailer under consignment sales with a revenue sharing contract. The manufacturer produces before, but charges price to sell the products through the retailer after the demand curve is revealed. The retailer deducts a fraction from the selling price for each unit sold and remits the balance to manufacturer. We refer to the capability whereby firms delay price decision and make sales in response to actual market condition as postponement. We find that, when market demand admits a multiplicative structure, the revenue share and allocation of channel profit between the firms when they have postponement capability are similar to when they do not have such capability. Postponement improves the profits of individual firms. Such an effect is more phenomenal in the centralized system than in decentralized system, and when the market demand is more sensitive to price changes. However, it causes the profit loss, defined as the percentage deviation of channel profit in the decentralized system relative to the centralized system, to worsen, and the gap widens with retailer's sales cost. When the demand has an additive structure, while the roles of postponement on firms' decisions differ slightly from those under the multiplicative structure, the structure of the strategic interactions between firms and relative channel performance are not significantly altered.

1. Introduction

Consignment is a popular form of business arrangement whereby the supplier retains inventory ownership and gets paid by the retailer based on the actual amount of units sold. Sellers on eBay, for instance, have long understood the benefits of consignment that enables them to obtain the inventory without the risk of holding the unsellable merchandise. Revenue sharing contract is usually in force under the consignment arrangement to govern the relationship between the firms. Such a contract naturally favors the consignor who has no money tied up in stock and bears no market risk since no payment is made to the consignee until the product is sold. More often than not, the consignor is the party that decides the allocation of the sales revenue.

To explore the consignment setting, the existing OM literature usually assumes that all the decisions on price and quantity are made before the actual demand curve is revealed. In the business world, fixed price has long been necessary to manage the enormous growth in volume and variety of products distributed over geographic areas. However, it is increasingly ineffective in today's market that is characterized by aggravated demand volatility with an enlarged pool of customers, competitors, and information. The capability to charge prices in response to the actual market conditions helps firms influence customer demand for better resource deployment. In the pharmaceutical industry, most companies charge prices after drug test results are in so that the market potential for the product can be fully assessed. The development of IT system has greatly reduced the transaction cost incurred in price adjustment by eliminating the need for people to be physically present in time and space to participate in the market. Changing a price used to mean huge costs, but the same task is now merely a database update. Delayed price decision will be more effective with the support of a physical system capable of timely and accurately delivering products to satisfy generated demand. Companies like UPS and FedEx provide specialized transportation and logistics services to fit for that purpose. We refer to the capability whereby firms delay price decision and make sales until observing the actual market condition as *postponement*.

Over the past years, the electronic manufacturing sector (EMS) has undergone a change from low-mix/high-volume manufacturing to high-mix/low-volume manufacturing. The original equipment manufacturers (OEMs) in EMS usually produce before taking orders, but set prices to sell products based on the demand signals received after the products are unveiled into market. The final products are sold to customers under consignment-like arrangements between OEMs and retailers. Microsoft, for instance, announced the launch date for Xbox 360 in North America, Europe, and Japan on the eve of Japan Game Show on September 18, 2005. To achieve the three-pronged launch, Microsoft reserved global production resources well in advance and finalized the prices to release in each region after a careful market study. It also contracted hundreds of local publishers to handle necessary packaging and delivery to

E-mail address: lgtjiang@polyu.edu.hk

0377-2217/$ - see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.ejor.2011.07.052

ensure that the logistics process satisfies the massive demand. E-tailers such as Amazon and eBay build platforms for millions of sellers and buyers to meet in the virtual space. The sellers can judge the market status to timely adjust prices and the amount of products for sale at no additional cost, with the logistics process in the hands of providers under consignment sales; sales revenues are shared between involved parties.

This business trend raises an issue that has not been fully addressed in existing literature. That is, how does postponement affect the strategic interaction between supply chain partners when they are bonded by consignment sales with a revenue sharing contract? In particular, we want to investigate how postponement affects the contract term and the relative performance of involved parties. Also, we are interested in how channel behavior is affected by demand structure.

We consider a backbone supply chain model consisting of one manufacturer and one retailer under consignment sales with a revenue sharing contract. We use "she" to refer to the manufacturer and "he" to the retailer. In a Stackelberg setting, the retailer first offers a take-it-or-leave-it revenue share to the manufacturer. The manufacturer will accept the offer as long as she expects to earn a positive profit (that is, we normalize her reservation value to zero). Upon accepting the offer, the manufacturer produces and leaves the products with the retailer before observing the actual demand curve, but charges a price to sell the products through the retailer after the demand curve is revealed. Sales revenue is allocated between the firms according to the pre-determined term. Such a sequence differs from that in the standard contracting literature in that the price decision and the resultant sales are determined after the actual demand curve is observed.

The above supply chain model, though simple, is rich enough to capture the key tradeoffs and strategic interactions between firms. The retailer takes the lead in selecting an allocation of sales revenue between himself and the manufacturer, and the manufacturer produces before demand realization but makes price decision in response to the actual market condition. We first analyze a demand model in the form of a deterministic price-dependent function multiplied by a random factor. Our results show that, when the expected demand function assumes an iso price elastic form, irrespective of postponement capability, the retailer will choose the same revenue share and channel profit is allocated between firms according to the same proportions. That is, postponement does not alter the relative market positions of the manufacturer and the retailer.

Postponement improves the profits of firms by mitigating their exposures to market risk, and benefits the customers as well with an enhanced product availability and a lowered price. Such effects are more phenomenal in the centralized system than in the decentralized system, and in a more price sensitive market where delayed pricing plays a more influential effect. On the other hand, profit loss, defined as the percentage deviation in channel profit in decentralized system relative to that in centralized system, will worsen when the firms have postponement capability, and the gap will widen with the retailer's sales cost. We attribute this to the effects of delayed pricing on the effective cost for produced units in different decision settings. Without postponement, all the produced units are deployed into market and the effective costs incurred for each unit are identical in the two decision settings. With postponement, however, delayed pricing only ensures that all the produced units are consumed, or *stock-clearing pricing*, in the decentralized system, but generates the best sales with some units held back, or *optimal pricing*, when the realized market is small and clears the stock when the realized market is large in the centralized system. As a result, the average effective cost incurred for each produced unit is lower in the centralized system than in the decentralized system, and the cost difference will increase with the retailer's sales cost that matters in the ex-post price decision in the centralized system. This ultimately affects the relative channel performance.

We have also investigated an alternative demand model, the additive demand structure, where, in addition to optimal pricing and stock-clearing pricing, postponement allows firms to price responsively to deter demands from occurring when the actual market is too small to justify sales. We find that the structural properties regarding the performance of the decentralized system relative to that in the centralized system, and the relative performance of firms, applicable under multiplicative demand structure, are to a large extent carried over to the additive demand structure. Consignment sales with a revenue sharing contract thus strongly favors the retailer, who decides the revenue share term, and grants him a prominent position over the manufacturer, even when firms can postpone critical decisions until the actual demand curve is revealed.

1.1. Related literature

Our paper is relevant to the literature on revenue sharing contracts, consignment sales, joint price and production decisions, and resource flexibility. Cachon and Lariviere (2001) study a model with an exogenous retail price where a downstream manufacturer facing uncertain demand offers contracts to motivate component suppliers to build production capacity. In one contract, the manufacturer offers a purchase price, as a "share" of the selling price or sales revenue, to the supplier. This is essentially a revenue sharing scheme. Gerchak and Wang (2000) consider an assembly system, where an assembler of a final product arranges the allocation of sales revenue between herself and several suppliers each producing a different component for the final product; the suppliers then decide the production quantities for their respective components. They derive the equilibrium revenue share allocations and production quantities. Both papers assume that the final product has a fixed price. With price sensitive and uncertain demand, Wang et al. (2004) consider a setting of one manufacturer and one retailer under a consignment sales arrangement with revenue sharing, and characterize the optimal revenue share and the channel performance in a decentralized system. In the same setting, Li et al. (2009) apply Nash bargaining model to find the revenue share that achieves cooperation between the manufacturer and the retailer. Wang (2006) extends to a setting that includes multiple manufacturers who decide quantities and prices either sequentially or simultaneously, and evaluates the effects of decision sequence.

Revenue sharing as a business arrangement has also been applied to settings other than consignment sales. In the video rental industry, a supplier charges a retailer an upfront wholesale price *plus* a share of sales revenue. It is the upstream supplier that determines the contract terms, followed by a downstream retailer that chooses an order quantity and a retail price. Cachon and Lariviere (2001) show that such a contract can coordinate a single-retailer channel. Dana and Spier (2001) use this contract in a setting with a perfectly competitive market for the downstream retailers. Other papers on similar issues include Gerchak et al. (2001), Mortimer (2000), and Pasternack (2000).

In our model, the idea that the supplier makes channel production/inventory decisions is similar to what we see with a vendor-managed inventory (VMI) program like those of Fry et al. (2001), Aviv and Federgruen (2001), and the references therein. Ru and Wang (2010) conduct a comparative study on who should control the inventory under consignment sales arrangement. They show that when the retailer controls the inventory, the supply chain loses at least 26.4% of its first-best profit, while, when the supplier controls the inventory, it loses just or no more than 26.4% of the first best. When implementing the consignment sales program in