Coordination of Decentralized Supply Chains: A Literature Review

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Abstract

Due to the fact that the double margin exists in the decentralized supply chain, many papers focus on the coordination of decentralized supply chain. In this paper, we classify these papers into three parts according to the structure of supply chain. The first kind of supply chain consists of one upstream supplier and one downstream retailer. The second one consists of multiple suppliers and a single retailer. The last one refers to the supply chain with multiple suppliers and a single retailer. This paper can enable readers to get the knowledge of existing research on supply chain coordination. We also give some interesting future research concerning this topic.

Key words: Supply chain; Demand uncertainty; Double margin; Coordination

INTRODUCTION

With the rapid development of intra-production specialization, the planning process of a final product is seldom completed by one firm. This results that the production of a final product needs the cooperation of some companies. A supply chain can be viewed as the cooperation between/ among vertical related firms. However, in a decentralized supply chain, each player has its own objective rather than that of the entire supply chain. For example, with a wholesale price contract, an upstream supplier always chooses a wholesale price which is higher than production cost to be charged to the downstream retailer. As a result, the order quantity of the downstream retailer, and hence, the total expected profit of upstream supplier and the downstream retailer is less than that of central supply chain. Spengler (1950) first observes this phenomenon and calls it "double margin", but he does not concern how to eliminate the "double margin". After 35 years, Pasternack (1985) notices the importance of eliminating the double margin (improves the production quantity and increase the total expected profit of supply chain), and proposes the concept of "coordination of supply chain".

Supply chain coordination is not very complex, but it is important to study two questions. First, a contract/ mechanism is said to coordinate the supply chain if the set of supply chain optimal decisions is a Nash equilibrium, i.e., no firm can benefit from a deviation from the set of supply chain optimal decisions. In a decentralized push supply chain, the action to coordinate is the downstream retailer's order quantity; and in a decentralized pull supply chain, the action to coordinate is the upstream supplier's production quantity (the terms "push" and "pull" are both adopted from Cachon 2004). When the order/production quantity is coordinated, the total expected profit of upstream and downstream players in a decentralized setting is equal to that of centralized setting. Second, which coordination contract/mechanism is acceptable to supply chain players? If a non-coordination contract is dominated by a coordinating contract, i.e., each firm's expected profit is no worse off and at least one firm is strictly better off with the coordinating contract. When the

coordination contract has sufficient flexibility to allocate the coordinated supply chain's expected profit among supply chain players arbitrarily, there exists contract parameters to enable coordination contract dominates a non-coordination contract (Cachon, 2003).

The rest of the paper is organized as follows. In Section 2, we review the literature on the coordination of supply chain (hereafter referred as one-supplier-one-retailer supply chain) consisting of one upstream supplier and one downstream retailer. Subsequently, Section 3 reviews the literature on the coordination of supply chain (hereafter referred as one-supplier-multiple-retailers supply chain) where one upstream supplier sells its product to multiple downstream retailers. The coordination of supply chain (hereafter referred as multiple-suppliers-one-retailer supply chain) where multiple upstream firms sell their products to a downstream retailer is reviewed in Section 4. Finally, Section 5 summarizes the directions of future research.

1. COORDINATION OF ONE-SUPPLIER-ONE-RETAILER SUPPLY CHAIN

One-supplier-one-retailer supply chain is the basic setting. There are many contracts can be used to coordinate this kind of model.

1.1 Buy Back Contract

With a buy back contract, the upstream supplier charges the downstream retailer a wholesale price w per unit purchased, but also pays the downstream retailer b per unit remaining at the end of the selling season.

Padmanabhan and Png (1995) discusses returns policies which are commonplace in industries, such as computing and publishing as well as apparel, cosmetics and electrical appliances. Suo and Jin (2004) study the coordination of supply chain assuming that the marginal cost of the retailer is private information, they show that buy back contract can achieve the supply chain coordination. Ye and Li (2006) use buy back contract to coordinate the supply chain with a risk-averse retailer. Su and Zhang (2008) study the impact of strategic customer behavior on supply chain's expected profit and show that the buyback contract can be used as an incentive-coordinating device as well as a commitment device. Zhang et al. (2005) study a supply chain with a risk-neutral supplier and a loss-averse retailer. They show that the production quantity of decentralized supply chain is less than that of centralized supply chain, and find that the supply chain can be achieved by buy back contract.

1.2 Revenue-Sharing Contract

With a revenue sharing contract, the upstream supplier charges the downstream retailer a wholesale price w per unit purchased; the downstream retailer gives the upstream supplier a percentage of its sale revenue r.

Cachon and Lariviere (2005) study the coordination in decentralized supply chain with revenue-sharing contract, and show that the supplier can allocate the expected profit of supply chain between the supplier and the retailer arbitrarily, and thus the Pareto-improvement is achieved. Wang et al. (2008) coordinate the supply chain with fuzzy demand, by using revenue-sharing contract. Linh and Hong (2008) study the channel coordination in a two-period newsboy problem through revenue sharing contract. Li and Hua (2008) investigate the coordination of supply chain with price-sensitive demand, by using revenue sharing contract. Yao et al. (2012) coordinate the supply chain with a risk-averse retailer through revenue sharing contract.

1.3 Quantity Flexibility Contract

With a quantity flexibility contract, the upstream supplier charges the downstream retailer different wholesale prices for different order quantities.

Kohli and Park (1994) coordinate the supply chain in which the supplier is the leader and the retailer is the follower, by quantity flexibility contract. Weng (1995a,1995b) coordinates the supply chain with price-sensitive demand, by quantity flexibility contract. Tsay (1999), and Tsay and Lovejoy (1999) illustrate that the quantity flexibility contract can enable the retailer's order quantity to be equal to that of centralized supply chain, and arbitrarily allocate the supply chain's expected profit between two players. Cachon and Lariviere (2001) study the supply chain coordination with demand forecasts, and show that the quantity flexibility contract conditionally coordinates the supply chain. Xu et al. (2003) deal with the problem of supply chain with nonlinear demand functions (demand variation makes the real production different from originally production). They show that such a supply chain can be coordinated by quantity flexibility contract. Qi et al. (2004) show that the quantity flexibility contract can coordinate the supply chain with demand disruption. Wu (2005) studies the supply chain coordination with bayesian updating, by using a quantity flexibility contract. Corbett and Groote (2000) and Burnetas et al. (2007) investigate the coordination of supply chain with asymmetric information and find that the coordination of supply chain can be achieved by quantity flexibility contract. Zhou and Yang (2006) investigate the coordination of supply chain with asymmetric information and price-sensitive demand. Wang and Wang (2008) investigate the coordination of supply chain with quantity flexibility contract, assuming that the production rate for manufacturer is finite and the unit inventory holding cost for the retailer is asymmetric.

1.4 Sales Rebate Contract

With a sales rebate contract, the upstream supplier first charges the downstream retailer a wholesale price w per unit purchased, and then gives the retailer an r rebate per

unit sold above a threshold *m*.

Taylor (2002) and Xu et al. (2008) study the supply chain coordination under channel rebates with sales effort effects and gives the condition of coordination. Krishnan et al. (2004) investigates the coordination of supply chain with retailer promotional effort. They show a mechanism combining a buy-back and promotional cost-sharing agreement can be used to coordinated the supply chain conditionally.

1.5 Other Contracts

Beside the above contracts, many other contracts are studied to coordinate the supply chain, such as option contract, trade credit contract, risk-sharing contract.

Barnes-schuster et al. (2004) show how option contract coordinates the supply chain. They find that the supply chain can be coordinated if and only if the exercise price is piecewise linear. Burnetas and Ritchen (2005) study the coordination of supply chain when the demand is downward, sloping, by option contract. Ren and Chen (2009) investigate supplier's delay in payments and supply chain coordination under retailer's sales effort, by using trade credit contract. They construct the one-supplier-one-retailer supply chain model, and analyze the coordination condition. Wu and Xu (2009) investigate the coordination in decentralized supply chain with asymmetric information, they show that linear transfer payment schema can be used by the retailer to achieve the supply chain coordination. Gan et al. (2005) investigate how a supply chain involving a risk-neutral supplier and a downside-risk-averse retailer can be coordinated. They find that the standard buy-back or revenue-sharing contracts can not coordinate such a system and design a risk-sharing contract to coordinate the model. Chen et al. (2006) propose a risk sharing contract to coordinate the supply chain. The risk sharing contract says that the retailer partially compensates for the supplier's loss that is attributable to the overproduction in the first stage, and the supplier provides a partial credit for the retailer's loss that results from overstocking in the second stage. LIU Jian(2011, 2012) consider the games model between manufacturer and retailer under government subsidy in the wholesale price contract, evaluates the impact of different government subsidies model on the product price, demand, enterprise performance, and give us a new perspective on designing of supply chain coordination mechanisms.

2. COORDINATION OF ONE-SUPPLIER-MULTIPLE-RETAILERS SUPPLY CHAIN

Eppen and Iyer (1997) focus on backup agreements between a supplier and multiple retailers. The results show that backup arrangements have a substantial impact on expected profits and result in an increase in the production quantity. Agrawal and Seshadri (2000) study the coordination of a supply chain with a supplier and multiple risk-averse retailers. Bernstein and Federgruen (2005) consider decentralized supply chain with competing (noncompeting) retailers, by wholesale price contract. They design contractual arrangements which allow the decentralized setting to perform as well as a centralized one. Khouja and Mehrez (1996) solve a multi-product newsboy model in which multiple discounts are used to sell excess inventory under a budget constraint or storage. They show that such a quantity flexibility contract can achieve supply chain coordination. Plambeck and Taylor (2005) coordinate the supply chain with a supplier and multiple retailers, by quantity flexibility contract. Kim and Hwang (1989) maximize: the gain of the buyer, the economic gain of the supplier resultant from revising price and order size, and the sum of the gains of both parties. They suggest how the supplier can induce the retailers to a order-size level of mutual benefit and predetermined price. Yao et al. (2008) study the coordination of supply chain with a supplier and two competing retailers, by a revenue-sharing contract. Zhang et al. (2012) extend the model of Yao et al. (2008) to demand disruptions setting.

3. COORDINATION OF MULTIPLE-SUPPLIERS-ONE-RETAILER SUPPLY CHAIN

3.1 Substitutable Suppliers

Wang and Liu (2008) study the coordination of supply chain with multiple suppliers and a retailer, by an option contract. Gui et al. (2011) deal with supplier's delay in payments and supply chain coordination under retailer's sales effort. They construct the multiple-one supply chain model and analyze the coordination condition.

3.2 Complementary Suppliers

The second kind of multiple-one supply chain is assembly system (i.e., assembly supply chain, Leng and Parlar 2010). In an assembly system, there are multiple upstream firms sell complementary components to a downstream firm. The upstream firms not only compete with each other (for example, all upstream firms strive to increase their individual component prices charged to the downstream firm to gain an advantage on sales revenue); but also cooperate with each other (for example, to assemble a final product, each upstream firm's component should be matched by all other components). Gerchak and Wang are first to study the coordination in decentralized assembly systems with random demand. They show that a wholesale-price-driven scheme can be used to coordinate a push assembly system and a revenue-plus-surplus-subsidy incentive scheme can be used to coordinate a pull model. Zou et al. (2008) extend the model of Gerchak and Wang

(2004) to the two-period setting. Gurnani and Gerchak (2007) and Yan et al. (2010) investigate the coordination in decentralized assembly system with random yield. Güler and Bilgic (2009) investigate the coordination in decentralized assembly system in which the demand and the yield are both random. Zhang et al. (2008) investigate the coordination in decentralized assembly system where the final product is sold in two configurations. Fu et al. (2013) study the coordination in decentralized assembly system with loss-averse suppliers.

CONCLUDING REMARKS

Although there are many studies on supply chain coordination, few studies classify and summarize these studies. In this paper, we review the exciting studies on supply chain coordination from the perspective of supply chain framework. That is, one-supplier-one-retailer supply chain, one-supplier-multiple-retailers supply chain, multiple-suppliers-one-retailer supply chain.

There are many opportunities for future research on supply chain coordination. An interesting topic is to allow the uncertain exchange rate (the existing studies on supply chain coordination mainly focus on uncertain demand, yield, etc.). It is also worth investigating the coordination of supply chain with multiple suppliers and multiple retailers.

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