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Chapter 6

Supply Chain Coordination with Contracts

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1 Introduction

Optimal supply chain performance requires the execution of a precise set of actions. Unfortunately, those actions are not always in the best interest of the members in the supply chain, i.e., the supply chain members are primarily concerned with optimizing their own objectives, and that self-serving focus often results in poor performance. However, optimal performance is achievable if the firms coordinate by contracting on a set of transfer payments such that each firm's objective becomes aligned with the supply chain's objective.

This chapter reviews and extends the supply chain literature on the management of incentive conflicts with contracts. Numerous supply chain models are discussed, roughly presented in order of increasing complexity. In each model the supply chain optimal actions are identified. In each case the firms could implement those actions, i.e., each firm has access to the information required to determine the optimal actions and the optimal actions are feasible for each firm.[1] However, firms lack the incentive to implement those actions. To create that incentive the firms can adjust their terms of trade via a contract that establishes a transfer payment scheme. A number of different contract types are identified and their benefits and drawbacks are illustrated.

[1] Even in the asymmetric information models there is an assumption that the firms can share information so that all firms are able to evaluate the optimal policies. Nevertheless, firms are not required to share information. See Anand and Mendelson (1997) for a model in which firms are unable to share information even though they have the incentive to do so.

The first model has a single supplier selling to a single retailer that faces the newsvendor problem. In that model the retailer orders a single product from the supplier well in advance of a selling season with stochastic demand. The supplier produces after receiving the retailer's order and delivers her production to the retailer at the start of the selling season.[2] The retailer has no additional replenishment opportunity. How much the retailer chooses to order depends on the terms of trade, i.e., the contract, between the retailer and the supplier.

The newsvendor model is not complex, but it is sufficiently rich to study three important questions in supply chain coordination. First, which contracts coordinate the supply chain? A contract is said to coordinate the supply chain if the set of supply chain optimal actions is a Nash equilibrium, i.e., no firm has a profitable unilateral deviation from the set of supply chain optimal actions. Ideally, the optimal actions should also be a unique Nash equilibrium; otherwise, the firms may 'coordinate' on a suboptimal set of actions. In the newsvendor model the action to coordinate is the retailer's order quantity (and in some cases, as is discussed later, the supplier's production quantity also needs coordination). Second, which contracts have sufficient flexibility (by adjusting parameters) to allow for any division of the supply chain's profit among the firms? If a coordinating contract can allocate rents arbitrarily, then there always exists a contract that Pareto dominates a noncoordinating contract, i.e., each firm's profit is no worse off and at least one firm is strictly better off with the coordinating contract. Third, which contracts are worth adopting? Although coordination and flexible rent allocation are desirable features, contracts with those properties tend to be costly to administer. As a result, the contract designer may actually prefer to offer a simple contract even if that contract does not optimize the supply chain's performance. A simple contract is particularly desirable if the contract's efficiency is high (the ratio of supply chain profit with the contract to the supply chain's optimal profit) and if the contract designer captures the lion's share of supply chain profit.

Section 3 extends the newsvendor model by allowing the retailer to choose his retail price in addition to his stocking quantity. Coordination is more complex in this setting because the incentives provided to align one action (e.g., the order quantity) might cause distortions with the other action (e.g., the price). Not surprising, it is shown that some of the contracts that coordinate the basic newsvendor model no longer coordinate in this setting, whereas others continue to do so.

Section 4 extends the newsvendor model by allowing the retailer to exert costly effort to increase demand. Coordination is challenging because the

[2] The author adopts the convention (first suggested to him by Martin Lariviere) that the firm offering the contract is female and the accepting firm is male. When neither firm offers the contract, then the upstream firm is female, and the downstream firm is male.