Supply Contracts with Financial Hedging

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We study the performance of a stylized supply chain where two firms, a retailer and a producer, compete in a Stackelberg game. The retailer purchases a single product from the producer and afterward sells it in the retail market at a stochastic clearance price. The retailer, however, is budget constrained and is therefore limited in the number of units that he may purchase from the producer. We also assume that the retailer’s profit depends in part on the realized path or terminal value of some observable stochastic process. We interpret this process as a financial process such as a foreign exchange rate or interest rate. More generally, the process can be interpreted as any relevant economic index. We consider a variation (the flexible contract) of the traditional wholesale price contract that is offered by the producer to the retailer. Under this flexible contract, at \( t = 0 \) the producer offers a menu of wholesale prices to the retailer, one for each realization of the financial process up to a future time \( \tau \). The retailer then commits to purchasing at time \( \tau \) a variable number of units, with the specific quantity depending on the realization of the process up to time \( \tau \). Because of the retailer’s budget constraint, the supply chain might be more profitable if the retailer was able to shift some of the budget from states where the constraint is not binding to states where it is binding. We therefore consider a variation of the flexible contract, where we assume that the retailer is able to trade dynamically between zero and \( \tau \) in the financial market. We refer to this variation as the flexible contract with hedging. We compare the decentralized competitive solution for the two contracts with the solutions obtained by a central planner. We also compare the supply chain’s performance across the two contracts. We find, for example, that the producer always prefers the flexible contract with hedging to the flexible contract without hedging. Depending on model parameters, however, the retailer might or might not prefer the flexible contract with hedging.

Subject classifications: finance: portfolio, management; inventory/production: applications; procurement contract; financial constraints; supply chain coordination.


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1. Introduction

We consider the operation of a stylized supply chain with one producer and one retailer. The producer manufactures a single product, which it sells to the retailer. The retailer in turn sells the product in the retail market at a stochastic clearance price. We consider a noncooperative mode of operation in which both players maximize their own profit functions. In particular, we consider a Stackelberg game where the producer, acting as leader, proposes a retail price or a menu of prices to the retailer, who then decides how many units to order. As is customary in the supply chain literature (e.g., Lariviere 1998 and Tsay et al. 1998), we are interested in characterizing the solution of the game as well as its efficiency. We measure the efficiency using the so-called competition penalty, that is, the ratio of the noncooperative supply chain profits to the centralized supply chain profits (e.g., Cachon and Zipkin 1999).

Our model differs from previous work in two aspects. First, we assume that the retailer operates under a budget constraint. In particular, a limited amount of cash or working capital is available to the retailer for purchasing product units from the producer. Budget constraints are quite common in practice for a number of reasons. For example, many companies have only limited and/or costly access to credit markets. This could be due to (i) high levels of risk aversion in the financial markets, (ii) the presence of asymmetric information whereby management knows that the company is in much better shape than is generally perceived by the markets, or (iii) structural or legal reasons that make it difficult to raise capital. It is worth mentioning that some companies also choose to restrict their managers by imposing budget constraints on their actions.

The imposition of budget constraints has for the most part been ignored in the extensive research on supply chain management. A recent exception is the work by Buzzacott and Zhang (2004), where the interplay between inventory decisions and asset-based financing is investigated.

The second distinguishing aspect of our model is the existence of a financial market or economic index whose movements are correlated (we use the term “correlated” loosely in this paper when referring to any form of statistical dependence) with the supply chain’s profits. For example, if the producer sells to a foreign retailer and quotes prices in foreign currency units, then his profits, in units of his domestic currency, will be correlated with exchange rate movements. Similarly, if the retailer pays the producer...