A Cournot-Stackelberg Model of Supply Contracts with Financial Hedging

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Abstract

We study the performance of a stylized supply chain where multiple retailers and a single producer compete in a Cournot-Stackelberg game. At time $t = 0$ the retailers order a single product from the producer and upon delivery at time $T > 0$, they sell it in the retail market at a stochastic clearance price. We assume the retailers’ profits depend in part on the realized path of some tradeable stochastic process such as a foreign exchange rate, interest rate or more generally, some tradeable economic index. Because production and delivery do not take place until time $T$, the producer offers a menu of wholesale prices to the retailer, one for each realization of the process up to some time, $\tau$, where $0 \leq \tau \leq T$. The retailers’ ordering quantities therefore depend on the realization of the process until time $\tau$. We also assume, however, that the retailers are budget-constrained and are therefore limited in the number of units they may purchase from the producer. The supply chain might therefore be more profitable if the retailers were able to reallocate their budgets across different states of nature. In order to affect a (partial) reallocation, we assume that the retailers are also able to trade dynamically in the financial market. After solving for the Nash equilibrium we address such questions as: (i) whether or not the players would be better off if the retailers merged and (ii) whether or not the players are better off when the retailers have access to the financial markets. Our model can easily handle variations where, for example, the retailers are located in a different currency area to the producer or where the retailers must pay the producer before their budgets are available. Finally, we consider the case where the producer can choose the optimal timing, $\tau$, of the contract and we formulate this as an optimal stopping problem.


Keywords: Procurement contract, financial constraints, supply chain coordination.