

The Pricing of a Supply Contract under Uncertainty with Long-Range Dependence

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Abstract

This paper aims to address a contracting problem between upstream and downstream agents in a supply chain using a stochastic demand process with autocorrelation properties. For example, the quarterly global sales volumes of Apple's iPhone are highly autocorrelated over time although the time lag is as long as 10 quarters. Based on such empirical evidence, an autocorrelated demand process referred to as fractional Brownian motion is adopted in this paper. It is assumed that there are two echelons in the supply chain: business and consumer markets. The information flows fall into four categories: demand flow, marketing info flow, uncertainty flow, and premium charge flow. The downstream agent can transfer demand uncertainty to the upstream firm (uncertainty flow) by signing a supply contract (contracting agent). The demand in the consumer market is assumed to follow a fractional Brownian motion. Based on the fractional Ito formula for the real option model, the result demonstrates that the real option value can be an increasing or decreasing function of the degree of autocorrelation in which the real option value reaches its maximum at the critical point. As a consequence, the trading price determined in the supply contract without considering the autocorrelation of demand could be significantly undervalued or overvalued. In other words, to ensure a fair game in a contracting activity, the upstream agent should charge more for the trading price depending on the degree of autocorrelation in demand.

Keywords: Supply contract, uncertainty, fractional Brownian motion, autocorrelation.